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## IAS TREATABILITY STUDY REPORT

OPERABLE UNIT NO. 10 (SITE 35) MCB, CAMP LEJEUNE, NORTH CAROLINA

**CONTRACT TASK ORDER 0323** 

**NOVEMBER 14, 1996** 

Prepared for:

DEPARTMENT OF THE NAVY ATLANTIC DIVISION NAVAL FACILITIES ENGINEERING COMMAND Norfolk, Virginia

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## TABLE OF CONTENTS

			<u>r ugo</u>
EXEC	CUTIVE	SUMMARY	ES-1
1.0	INTR	ODUCTION	
110	1.1	Purpose and Organization	
	1.2	Site Background	
	1.2	1.2.1 Site Location and Description	
		1.2.2 Site History	
		1.2.3   Previous Investigations and Findings	
2.0	OVE	RVIEW OF IN-SITU AIR SPARGING TECHNOLOGY	2-1
2.0	2.1	Description	
	2.1	Limitations	2-1
	2.2	Treatability Study Design Basis	
3.0	TREA	ATABILITY STUDY OBJECTIVES	3-1
4.0	MON	ITORING WELL AND SOIL GAS PROBE INSTALLATION	4-1
	4.1	Monitoring Well Installation	4-1
		4.1.1 Plume B	
		4.1.2 Plume C	4-2
	4.2	Soil Gas Probe Installation	4-3
	4.3	Geology and Hydrogeology	4-3
	т.2	4.3.1 Plume B	
		4.3.2 Plume C	
5.0	TDF	ATABILITY STUDY PROCEDURES AND OPERATION	5-1
5.0	5.1	Pre-Study Sampling	
	J.1	5.1.1 Soil Gas Monitoring	5-1
		5.1.2 Groundwater Monitoring	
	5.0	Study Implementation	
	5.2		5-1
			5-7
			5-2
		5.2.3 Study Sampling	
	5.3	Post-Study Sampling	
		5.3.1 Soil Gas Monitoring	
		5.3.2 Groundwater Monitoring	
6.0		ATABILITY STUDY RESULTS	
	6.1	Dissolved Oxygen	
		6.1.1 Shallow Monitoring Wells	
		6.1.2 Deep Monitoring Wells	
	6.2	Helium	6-2
		6.2.1 Shallow Monitoring Wells	6-2
		6.2.2 Deep Monitoring Wells	6-:
		6.2.3 Soil Gas Probes	6-3
	6.3	Static Water Levels	6

;

-

. .

------

1.1		ION
		and Organization
1.2		ckground 1-1
	1.2.1	Site Location and Description 1-1
	1.2.2	Site History
	1.2.3	Previous Investigations and Findings 1-3
OVEI		OF IN-SITU AIR SPARGING TECHNOLOGY
2.1		ption
2.2		ions
2.3	Treatab	bility Study Design Basis
TREA	TABILI	TY STUDY OBJECTIVES 3-1
MON	ITORIN	G WELL AND SOIL GAS PROBE INSTALLATION4-1
4.1	Monito	ring Well Installation
	4.1.1	Plume B
	4.1.2	Plume C
4.2	Soil Ga	as Probe Installation
4.3	Geolog	y and Hydrogeology
	4.3.1	Plume B
	4.3.2	Plume C 4-5
TRE	ATABIL	TTY STUDY PROCEDURES AND OPERATION
<b>TRE</b> 5.1		udy Sampling
	Pre-Str 5.1.1	ady Sampling
5.1	Pre-Str 5.1.1 5.1.2	udy Sampling       5-1         Soil Gas Monitoring       5-1         Groundwater Monitoring       5-1
	Pre-Str 5.1.1 5.1.2 Study 2	udy Sampling       5-1         Soil Gas Monitoring       5-1         Groundwater Monitoring       5-1         Implementation       5-1
5.1	Pre-Sta 5.1.1 5.1.2 Study 5.2.1	udy Sampling       5-1         Soil Gas Monitoring       5-1         Groundwater Monitoring       5-1         Implementation       5-1         In-Situ Air Sparging Equipment       5-1
5.1	Pre-Str 5.1.1 5.1.2 Study 5.2.1 5.2.2	udy Sampling5-1Soil Gas Monitoring5-1Groundwater Monitoring5-1Implementation5-1In-Situ Air Sparging Equipment5-1In-Situ Air Sparging System Performance5-2
5.1 5.2	Pre-Sta 5.1.1 5.1.2 Study 5.2.1 5.2.2 5.2.3	udy Sampling5-1Soil Gas Monitoring5-1Groundwater Monitoring5-1Implementation5-1In-Situ Air Sparging Equipment5-1In-Situ Air Sparging System Performance5-2Study Sampling5-2
5.1	Pre-Sta 5.1.1 5.1.2 Study 2 5.2.1 5.2.2 5.2.3 Post-S	udy Sampling5-1Soil Gas Monitoring5-1Groundwater Monitoring5-1Implementation5-1In-Situ Air Sparging Equipment5-1In-Situ Air Sparging System Performance5-2Study Sampling5-2tudy Sampling5-3
5.1 5.2	Pre-Sta 5.1.1 5.1.2 Study 5.2.1 5.2.2 5.2.3	udy Sampling5-1Soil Gas Monitoring5-1Groundwater Monitoring5-1Implementation5-1In-Situ Air Sparging Equipment5-1In-Situ Air Sparging System Performance5-2Study Sampling5-2
5.1 5.2 5.3	Pre-Sta 5.1.1 5.1.2 Study 5.2.1 5.2.2 5.2.3 Post-S 5.3.1 5.3.2	udy Sampling5-1Soil Gas Monitoring5-1Groundwater Monitoring5-1Implementation5-1In-Situ Air Sparging Equipment5-1In-Situ Air Sparging System Performance5-2Study Sampling5-2tudy Sampling5-3Soil Gas Monitoring5-3Groundwater Monitoring5-3
<ul><li>5.1</li><li>5.2</li><li>5.3</li><li>TRE</li></ul>	Pre-Sta 5.1.1 5.1.2 Study 5 5.2.1 5.2.2 5.2.3 Post-S 5.3.1 5.3.2 ATABIL	udy Sampling5-1Soil Gas Monitoring5-1Groundwater Monitoring5-1Implementation5-1In-Situ Air Sparging Equipment5-1In-Situ Air Sparging System Performance5-2Study Sampling5-3Soil Gas Monitoring5-3Groundwater Monitoring5-3Soil Gas Monitoring5-3ITY STUDY RESULTS6-1
5.1 5.2 5.3	Pre-Sta 5.1.1 5.1.2 Study 5.2.1 5.2.2 5.2.3 Post-S 5.3.1 5.3.2 ATABIL Dissol	udy Sampling5-1Soil Gas Monitoring5-1Groundwater Monitoring5-1Implementation5-1In-Situ Air Sparging Equipment5-1In-Situ Air Sparging System Performance5-2Study Sampling5-3Soil Gas Monitoring5-3Groundwater Monitoring5-3ITY STUDY RESULTS6-1ved Oxygen6-1
<ul><li>5.1</li><li>5.2</li><li>5.3</li><li>TRE</li></ul>	Pre-Sta 5.1.1 5.1.2 Study 5 5.2.1 5.2.2 5.2.3 Post-S 5.3.1 5.3.2 <b>ATABIL</b> Dissol 6.1.1	udy Sampling5-1Soil Gas Monitoring5-1Groundwater Monitoring5-1Implementation5-1In-Situ Air Sparging Equipment5-1In-Situ Air Sparging System Performance5-2Study Sampling5-3Soil Gas Monitoring5-3Groundwater Monitoring5-3Groundwater Monitoring5-3ITY STUDY RESULTS6-1shallow Monitoring Wells6-1
5.1 5.2 5.3 TRE 6.1	Pre-Sta 5.1.1 5.1.2 Study 5.2.1 5.2.2 5.2.3 Post-S 5.3.1 5.3.2 <b>ATABIL</b> Dissol 6.1.1 6.1.2	udy Sampling5-1Soil Gas Monitoring5-1Groundwater Monitoring5-1Implementation5-1In-Situ Air Sparging Equipment5-1In-Situ Air Sparging System Performance5-2Study Sampling5-3Soil Gas Monitoring5-3Groundwater Monitoring5-3Groundwater Monitoring5-3ITY STUDY RESULTS6-1Shallow Monitoring Wells6-1Deep Monitoring Wells6-2
<ul><li>5.1</li><li>5.2</li><li>5.3</li><li>TRE</li></ul>	Pre-Str 5.1.1 5.1.2 Study 5 5.2.1 5.2.2 5.2.3 Post-S 5.3.1 5.3.2 <b>ATABIL</b> Dissol 6.1.1 6.1.2 Heliur	udy Sampling5-1Soil Gas Monitoring5-1Groundwater Monitoring5-1Implementation5-1In-Situ Air Sparging Equipment5-1In-Situ Air Sparging System Performance5-2Study Sampling5-3Soil Gas Monitoring5-3Groundwater Monitoring5-3ITY STUDY RESULTS6-1ved Oxygen6-1Shallow Monitoring Wells6-2n6-2
5.1 5.2 5.3 TRE 6.1	Pre-Sta 5.1.1 5.1.2 Study 5.2.1 5.2.2 5.2.3 Post-S 5.3.1 5.3.2 ATABIL Dissol 6.1.1 6.1.2 Heliun 6.2.1	udy Sampling5-1Soil Gas Monitoring5-1Groundwater Monitoring5-1Implementation5-1In-Situ Air Sparging Equipment5-1In-Situ Air Sparging System Performance5-2Study Sampling5-3Soil Gas Monitoring5-3Groundwater Monitoring5-3Groundwater Monitoring5-3ITY STUDY RESULTS6-1Ned Oxygen6-1Shallow Monitoring Wells6-2Shallow Monitoring Wells6-2
5.1 5.2 5.3 TRE 6.1	Pre-Sta 5.1.1 5.1.2 Study 5.2.1 5.2.2 5.2.3 Post-S 5.3.1 5.3.2 <b>ATABIL</b> Dissol 6.1.1 6.1.2 Helium 6.2.1 6.2.2	udy Sampling5-1Soil Gas Monitoring5-1Groundwater Monitoring5-1Implementation5-1In-Situ Air Sparging Equipment5-1In-Situ Air Sparging System Performance5-2Study Sampling5-3Soil Gas Monitoring5-3Groundwater Monitoring5-3Groundwater Monitoring5-3ITY STUDY RESULTS6-1Shallow Monitoring Wells6-2Shallow Monitoring Wells6-2Shallow Monitoring Wells6-2Deep Monitoring Wells6-3
5.1 5.2 5.3 TRE 6.1	Pre-Sta 5.1.1 5.1.2 Study 5.2.1 5.2.2 5.2.3 Post-S 5.3.1 5.3.2 ATABIL Dissol 6.1.1 6.1.2 Helium 6.2.1 6.2.2 6.2.3	udy Sampling5-1Soil Gas Monitoring5-1Groundwater Monitoring5-1Implementation5-1In-Situ Air Sparging Equipment5-1In-Situ Air Sparging System Performance5-2Study Sampling5-2tudy Sampling5-3Soil Gas Monitoring5-3Groundwater Monitoring5-3ITY STUDY RESULTS6-1ved Oxygen6-1Shallow Monitoring Wells6-1

## TABLE OF CONTENTS (Continued)

<u>Page</u>
-------------

	6.4	Groundwater Analytical Results				
	6.5	Air Sampling Analytical Results				
	6.6	Radius of Influence				
		6.6.1 Deep Air Injection Test				
		6.6.2 Shallow Air Injection Test				
	6.7	Additional Groundwater Sample Results				
7.0	CONCLUSIONS AND RECOMMENDATIONS					
	7.1	Conclusions				
	7.2	Recommendations				
8.0	REFI	ERENCES				

## **APPENDICES**

А	Hydrogeologic Cross Sections
В	Contaminant Concentration Calculations
~	

C Soil Boring Logs

## LIST OF TABLES

1-1 Organic COCs that Exceed Remediation Levels

- 4-1 Monitoring Well Construction Details Plume B
- 4-2 Monitoring Well Construction Details Plume C
- 5-1 Pre-Test Sampling Matrix Plume B
- 5-2 Test Phase Durations Plume B
- 5-3 Treatability Study Test Sampling Matrix Plume B
- 5-4 Post-Test Sampling Matrix Plume B

6-1 Shallow Monitoring Well Dissolved Oxygen Concentrations - Plume B

6-2 Deep Monitoring Well Dissolved Oxygen Concentrations - Plume B

6-3 Shallow Monitoring Well Percent Helium by Volume - Plume B

- 6-4 Deep Monitoring Well Percent Helium by Volume Plume B
- 6-5 Soil Gas Probe Percent Helium by Volume Plume B
- 6-6 Pre-Test Groundwater Analytical Results Plume B
- 6-7 Deep Air Injection, Phase I, Groundwater Analytical Results Plume B
- 6-8 Deep Air Injection, Phase II, Groundwater Analytical Results Plume B
- 6-9 Shallow Air Injection, Phase I, Groundwater Analytical Results Plume B
- 6-10 Shallow Air Injection, Phase II, Groundwater Analytical Results Plume B
- 6-11 Post-Test Groundwater Analytical Results Plume B
- 6-12 Air Sampling Analytical Results Plume B

## LIST OF TABLES (Continued)

- 6-13 Comparison of Positive Detections to Ambient Air RBCs
- 6-14 Supplemental Post-Test Groundwater Analytical Results Plume B
- 6-15 Supplemental Post-Test Groundwater Analytical Results Plume C

#### LIST OF FIGURES

- 1-1 Camp Lejeune and Site 35 Location Map
- 1-2 Site Plan

1-3 Detected Organics in Upper Portion of Surficial Aquifer

- 1-4 Detected Organics in Lower Portion of Surficial Aquifer
- 1-5 Groundwater Contour Map for Surficial Aquifer
- 1-6 Cross Section Location
- 1-7 Hydrogeologic Cross Section
- 2-1 RAA 4: In Situ Air Sparging and Off-Gas Carbon Adsorption Site Plan
- 2-2 Summary of Surficial Aquifer Contamination in the Treatability Study Area
- 2-3 Detected BTEX and Total Chlorinated Solvents in Surficial Aquifer (April 1996)
- 2-4 Conceptual Contaminant Plumes Intercepting Sparging Curtain
- 2-5 Plume B Pilot Test Proposed Sparging Wells
- 2-6 Plume C Pilot Test Proposed Sparging Wells

4-1 Monitoring Well, Air Injection Well, and Soil Gas Probe Location Map - Plume B

- 4-2 Monitoring Well and Air Injection Well Location Map Plume C
- 4-3 Geologic Cross-Section Locations Plume B
- 4-4 Cross-Section A-A'
- 4-5 Cross-Section B-B'
- 4-6 Cross-Section C-C'
- 4-7 Cross-Section D-D'
- 4-8 Geologic Cross-Section Location Plume c
- 4-9 Cross-Section A-A'
- 4-10 Cross-section B-B'
- 4-11 Cross-section C-C'

5-1 IAS Process Flow Diagram

6-1 Shallow Monitoring Wells Dissolved Oxygen Concentration Plot

6-2 Approximate Radius of Influence Deep Air Injection Test - Plume B

- 6-3 Approximate Radius of Influence Shallow Air Injection Test Plume B
- 6-4 Deep Monitoring Wells Dissolved Oxygen Concentration Plot

6-5 Shallow Monitoring Wells Percent Helium by Volume Plot

6-6 Soil Gas Probes Percent Helium by Volume Plot

6-7 Static Water Level Readings - Plume B

6-8 Air Sampling Locations - Plume B

6-9 Deep Air Injection Well - System Head Curve

- 6-10 Geologic Cross-Section Locations Plume B
- 6-11 Geologic Cross Section A-A' Plume B, Deep Air Injection Test

## LIST OF FIGURES (Continued)

v

- 6-12 Geologic Cross Section C-C' Plume B, Deep Air Injection Test
- 6-13 Geologic Cross Section D-D' Plume B, Deep Air Injection Test
- 6-14 Shallow Air Injection Well System Head Curve
- 6-15 Geologic Cross Section A-A' Plume B, Shallow Air Injection Test
- 6-16 Geologic Cross Section B-B' Plume B, Shallow Air Injection Test
- 6-17 Geologic Cross Section D-D' Plume B, Shallow Air Injection Test

7-1 Location of Proposed IAS Remediation System

# LIST OF ACRONYMS

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acfm	actual cubic feet per minute
ASTs	Aboveground Storage Tanks
Baker	Baker Environmental, Inc.
bgs	below ground surface
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfm	cubic feet per minute
CFR	Code of Federal Regulations
CHCs	Total Chlorinated Hydrocarbons
CLEAN	Comprehensive Long-Term Environmental Action Navy
DO	Dissolved Oxygen
DON	Department of the Navy
ESD	Explanation of Significant Differences
FFA	Federal Facilities Agreement
FS	Feasibility Study
gpm	gallons per minute
IAS	In Situ Air Sparging
LANTDIV	Atlantic Division, Naval Facilities Engineering Command
MCB	Marine Corps Base
µg/L	micrograms per liter
mg/L	milligrams per liter
NC DEHNR	North Carolina Department of Environment, Health and Natural Resources
NC DOT	North Carolina Department of Transportation
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
OU	Operable Unit
PID	Photoionization Detector
PRAP	Proposed Remedial Action Plan
psi	pounds per square inch
PVC	polyvinyl chloride
RAAs	Remedial Action Alternatives
RAOs	Remedial Action Objectives
RAC	Remedial Action Contract
RBCs	Risk-Based Concentrations
RCRA	Resource Conservation and Recovery Act

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## LIST OF ACRONYMS (Continued)

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RD	Remedial Design
ROD	Record of Decision
ROI	Radius of Influence
SARA	Superfund Amendments and Reauthorization Act
TLV	Threshold Limit Value
TWA	Time-Weighted Average
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
USTs	Underground Storage Tanks
VOCs	Volatile Organic Compounds

#### **EXECUTIVE SUMMARY**

#### **Introduction**

This report has been prepared by Baker Environmental, Inc. to present the results of the In-Situ Air Sparging (IAS) Treatability Study conducted at Operable Unit No. 10, Site 35 Camp Geiger Area Fuel Farm during the summer of 1996. This report includes a summary of the IAS treatability study activities and results, conclusions and recommendations. It has been submitted to USEPA Region IV; the NC DEHNR; Camp Lejeune Environmental Management Department; OHM Corporation; and to the Naval Facilities Engineering Command, Atlantic Division for their review.

#### Purpose of the IAS Treatability Study

The purpose of the treatability study was as follows: to assess the applicability of IAS technology in addressing the shallow groundwater contamination at Site 35 by evaluating the effectiveness, implementability, and cost of a full-scale treatment system; to obtain sufficient data to afford the development of a full-scale system remedial design; and finally to assess the impact of air emissions on human health and the environment, and verify that air emissions will not impact the proposed highway project.

## Site Location and Description

Camp Lejeune is located in Onslow County, North Carolina near the city of Jacksonville. It currently covers approximately 234 square miles and is bisected by the New River. Camp Geiger is located at the extreme northwest corner of Camp Lejeune and contains a mixture of troop housing, personnel support and training facilities. Camp Geiger is roughly bounded by Brinson Creek to the north and northeast, the abandoned Seaboard Railroad right of way to the east, Curtis Road to the south, and U.S. Route 17 to the west.

Site 35, Camp Geiger Area Fuel Farm refers a former fuel storage and dispensing facility that was located just north of the intersection of Fourth and "G" Streets. The Fuel Farm consisted primarily of five, 15,000-gallon aboveground storage tanks, a pump house, a fuel loading/unloading pad, an oil water separator, and a distribution island situated just north of the intersection of Fourth and "G" Streets. The facility actively served Camp Geiger and the New River Air Station from 1945 to the Spring of 1995, when it was demolished to make way for a six-lane divided highway proposed by the North Carolina Department of Transportation.

#### Site History

During the lifetime of the facility several releases of product occurred. Reports of a release from an underground distribution line near one of the ASTs date back to 1957-58. Apparently, the leak occurred as the result of damage to a dispensing pump. On another occasion, a leak in an underground line at the station was reportedly responsible for the loss of roughly 30 gallons per day of gasoline over an unspecified period (Law, 1992). The leaking line was subsequently sealed and replaced. In April 1990, an undetermined amount of fuel was discovered by Camp Geiger personnel along two unnamed drainage channels north of the Fuel Farm. Apparently, the source of the fuel, believed to be diesel or jet fuel, was an unauthorized discharge from a tanker truck.

Previous investigations have been conducted by Water and Air Research, Inc. (WAR), Environmental Science and Engineering (ESE), NUS Corporation (NUS), Law Engineering (Law), and Baker Environmental, Inc. (Baker).

## **IAS Treatability Study**

The IAS treatability study consisted of the following activities: monitoring well and soil gas probe installation; pre-study sampling; the treatability study that occurred in two tests (deep and shallow air injection); and post-study sampling. The IAS treatability study occurred between July 9, 1996 and August 29, 1996.

#### Monitoring Well and Soil Gas Probe Installation

A total of 12 monitoring wells and two air injection wells were installed at Plume B, while a total of eleven monitoring wells and one air injection well were installed at Plume C. Six soil gas probes were installed at Plume B to monitor the vadose zone during the performance of the treatability study at the site.

#### **Pre-Study Sampling**

Pre-study sampling was conducted for a duration of 24 hours prior to the start-up of the IAS system. The system consisted of monitoring soil gas and groundwater to establish a baseline set of physical and chemical data conditions in the vadose zone and surficial aquifer.

#### Treatability Study

The treatability study was conducted at Plume B in two separate tests. Both test consisted of two phases of different air flow rates. The first test consisted of injecting air into the lower portion of the surficial aquifer at 7.5 acfm and 20 acfm. The second test consisted of injecting air into the upper portion of the aquifer at 5 and 20 acfm.

An approximate radius of influence of 20 feet was observed during phase I (7.5 acfm) of the deep air injection test. Phase II (20 acfm) of the deep injection test yielded an approximate radius of influence of 25 feet. A radius of influence was not observed during phase I (5 acfm) of the shallow air injection test. Phase II (20 acfm) of the shallow air injection test yielded an approximate radius of influence of ten feet.

#### Post-Study Sampling

Post-study sampling was conducted for a duration of 24 hours following the commencement of the study. The sampling consisted of monitoring soil gas and groundwater at the site as it returns to steady conditions. The sampling also monitored any changes to the baseline physical and chemical data conditions in the aquifer and vadose zone that may have occurred as a result of the treatability study.

## Site Geology

In general the findings of the treatability study are consistent with the findings of the supplemental groundwater investigation and the remedial investigation. The upper most soils at Plume B consist of peat with lesser amounts of sand, silt, and clay. The upper most soils at Plume C consist of sand

with lesser amounts of silt and clay. Immediately below this are calcareous sands with varying amounts of shell and fossiliferous limestone fragments. A generally fine sand with lesser amounts of clay is present below the calcareous sands and shell/limestone fragments. This layer is generally known as the Castle Hayne confining unit and is colored a distinctive greenish-gray and has a noticeable change in moisture content, becoming dryer.

#### **Conclusions**

Based on the results of the IAS treatability study it can be concluded that:

- IAS via vertical air injection will have limited effectiveness remediating CHCs at the base of the surficial aquifer. The semi-confining unit is too impermeable to allow air injection below the base of the surficial aquifer and underneath the contaminants.
- Vertical air injection in the area of the Plume C treatability study wells is inappropriate due to the presence of a subsurface clay layer. This clay layer will inhibit the vertical release of contaminants to the atmosphere and may result in the horizontal migration of contaminants off site.
- Results of groundwater sampling indicate BTEX contamination is not present in the area of the Plume B or Plume C wells. There are three possible reasons for the lack of contamination at these locations:
  - 1) The source of the contamination has been removed during the previous soil removal action at the former fuel farm.
  - 2) The contamination has not migrated to the IAS treatability study location.
  - 3) The contamination is being naturally attenuated in the approximately 10foot thick peat bog located along the banks of Brinson Creek.
- Vertical air injection from the deep air injection wells did have a favorable impact at Plume B. A radius of influence of 20 feet was observed at a flow rate of 7.5 acfm. The radius of influence increased to approximately 30 feet when the air flow was increased to 20 acfm.
- Vertical air injection from the shallow air injection wells did not have a favorable impact at Plume B. Due to the lack of shear strength of the peat material, air pathways were unable to be developed and sustained from an air injection point just below the peat layer.
- Due to BTEX results, IAS, if implemented in the area between the eastern edge of the proposed right-of-way and Brinson Creek, will not impact the BTEX contamination.

## **Recommendations**

- An IAS system where air is injected horizontally along the top of the semi-confining layer is preferable to conventional vertical air injection. Such a system should be more effective in remediating the CHC and BTEX contamination at this site. It is estimated that the cost of this system should be approximately equal to RAA 3, Groundwater Collection and On-Site Treatment, which was identified as the preferred contingent alternative in the Final Interim ROD (Baker, 1995).
- Due to poor site conditions, difficult access, and a lack of BTEX contamination in groundwater in the area between the eastern edge of the proposed right-of-way and Brinson Creek, an IAS system will likely be more effective if constructed along the western edge of the proposed right-of-way as shown on Figure 7-1.
- A field pilot test of a horizontal IAS system should be conducted in the area west of the proposed right-of-way to ensure it's effectiveness prior to full-scale implementation.

#### 1.0 INTRODUCTION

This Treatability Study Report has been prepared by Baker Environmental, Inc. (Baker) under the United States Department of the Navy (DON), Atlantic Division, Naval Facilities Engineering Command (LANTDIV) Comprehensive Long-Term Environmental Action Navy (CLEAN) Program for Contract Task Order 0323, Operable Unit (OU) No. 10, Site 35 - Camp Geiger Area Fuel Farm, Marine Corps Base (MCB), Camp Lejeune, North Carolina. The treatability study was conducted as part of the Remedial Design (RD) for surficial groundwater at Site 35. This document has been prepared in accordance with the requirements of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) for remedial actions [40 Code of Federal Regulations (CFR) 300.430]. The NCP regulations were promulgated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly referred to as Superfund, and amended by the Superfund Amendments and Reauthorization Act (SARA) signed into law on October 17, 1986. The USEPA's document <u>Guide for Conducting Treatability Studies Under CERCLA</u> (USEPA, 1992) has been used as guidance for preparing this document.

Camp Lejeune was placed on the CERCLA National Priorities List (NPL) on October 4, 1989 (54 Federal Register 41015, October 4, 1989). The United States Environmental Protection Agency (USEPA) Region IV, the North Carolina Department of Environment, Health and Natural Resources (NC DEHNR) and the DON then entered into a Federal Facilities Agreement (FFA) for Camp Lejeune. The primary purpose of the FFA is to ensure that environmental impacts associated with past and present activities at Camp Lejeune are thoroughly investigated and appropriate CERCLA response/Resource Conservation and Recovery Act (RCRA) corrective action alternatives are developed and implemented as necessary to protect public health and the environment.

#### 1.1 Purpose and Organization

The purpose of this document is to present the results of the treatability study of in-situ air sparging (IAS) technology conducted at Site 35.

Section 1.0 of this document includes this introduction and site background information. Section 2.0 contains a description of in situ air sparging (IAS) technology and its limitations along with a discussion of remedial design/remedial action implementation considerations. The objectives of the treatability study are presented in Section 3.0. The monitoring well and soil gas probe installation details are provided in Section 4.0 along with a discussion of the site geology and hydrogeology. Section 5.0 contains the pilot test procedures and operations. The results from the pilot test are described in Section 6.0. Conclusions and recommendations for the pilot test are provided in Section 7.0.

## 1.2 Site Background

#### 1.2.1 Site Location and Description

Camp Lejeune is a training base for the U.S. Marine Corps, located in Onslow County, North Carolina. The Activity, as the base is referred to, covers approximately 236 square miles and includes 14 miles of coastline. Camp Lejeune is bounded to the southeast by the Atlantic Ocean, to the northeast by State Route 24, and to the west by U.S. Route 17. The town of Jacksonville, North Carolina, is located north of the Activity (see Figure 1-1).

Camp Geiger is located at the extreme northwest corner of Camp Lejeune. The main entrance to Camp Geiger is off U.S. Route 17, approximately 3.5 miles southwest of the city of Jacksonville, North Carolina. Site 35, the decommissioned Camp Geiger Area Fuel Farm, refers primarily to five, 15,000-gallon aboveground storage tanks (ASTs), a pump house, and a fuel unloading pad formerly situated within Camp Geiger just north of the intersection of Fourth and G Streets (see Figure 1-2).

Site 35 is contained within OU No. 10, one of 17 operable units at Camp Lejeune. An "operable unit," as defined by the NCP, is a discrete action that comprises an incremental step toward comprehensively addressing site problems.

The Interim Feasibility Study (FS) study area consists of a portion of OU No. 10 measuring approximately 18 acres. More specifically, the study area consists of contaminated groundwater in the portion of the surficial aquifer that is located roughly between the former fuel farm and Brinson Creek (see Figure 1-2).

## 1.2.2 Site History

Construction of Camp Geiger was completed in 1945, four years after construction of Camp Lejeune was initiated. Originally, the ASTs were used for the storage of No. 6 fuel oil, but were later converted for storage of other petroleum products including unleaded gasoline, diesel fuel, and kerosene. The date of their conversion is not known. The ASTs at the site are reported to be the original tanks. Demolition of the fuel farm ASTs was completed in 1995.

Product was dispensed from the ASTs via trucks and underground piping. Routinely, the ASTs at Site 35 supplied fuel to an adjacent dispensing pump. A leak in the underground line from the ASTs to the dispensing island was reportedly responsible for the loss of roughly 30 gallons per day of gasoline over an unspecified period (Law, 1992). The leaking line was subsequently sealed and replaced.

The ASTs at Site 35 were used to dispense gasoline, diesel, and kerosene to government vehicles and to supply underground storage tanks (USTs) in use at Camp Geiger and the nearby New River Marine Corps Air Station until the spring of 1995. The ASTs were supplied by commercial carrier trucks which delivered product to fill ports located on the fuel unloading pad at the southern end of the facility. Six short-run (120 feet maximum), underground fuel lines were utilized to distribute the product from the unloading pad to the ASTs.

Reports of a release from an underground distribution line near one of the ASTs date back to 1957-58 (ESE, 1990). Apparently, the leak occurred as the result of damage to a dispensing pump. At that time, the Camp Lejeune Fire Department estimated that thousands of gallons of fuel were released, although records of the incident cannot be located. The fuel reportedly migrated to the east and northeast toward Brinson Creek. Interceptor trenches were excavated and the captured fuel was ignited and burned.

Another abandoned underground distribution line extended from the ASTs to the former Mess Hall Heating Plant, located adjacent to D Street, between Third and Fourth Streets. The underground line dispensed No. 6 fuel oil to a UST which fueled the Mess Hall boiler. The Mess Hall, located across "D" Street to the west, is believed to have been demolished along with its Heating Plant in the 1960s.

In April 1990, an undetermined amount of fuel had been discovered by Camp Geiger personnel along the unnamed drainage channels north of the fuel farm. Apparently, the source of the fuel, believed

to be diesel or jet fuel, was an unauthorized discharge from a tanker truck that was never identified. The Activity reportedly initiated an emergency clean-up action that included the removal of approximately 20 cubic yards of soil.

Decommissioning of the fuel farm began in the spring of 1995 and was completed in July 1995. The ASTs were cleaned, dismantled and removed along with associated concrete foundations, slabs on grade, berms, and underground piping. The fuel farm was removed to make way for a six-lane, divided highway proposed by the North Carolina Department of Transportation (NC DOT) (see Figure 1-2).

In addition to the fuel farm dismantling, soil remediation activities began in August 1995 along the highway right-of-way as per an Interim Record of Decision (ROD) executed on September 15, 1994. To date, all identified contaminated soil has been excavated and removed from the site.

#### **1.2.3 Previous Investigations and Findings**

Previous investigations conducted at Site 35 include the Initial Assessment Study of Marine Corps Base, Camp Lejeune, North Carolina (WAR, 1983); Final Site Summary Report, MCB Camp Lejeune (ESE, 1990); Draft Field Investigation/Focused Feasibility Study, Camp Geiger Fuel Spill Site (NUS, 1990); Underground Fuel Investigation and Comprehensive Site Assessment (Law, 1992); Addendum Report of Underground Fuel Investigation and Comprehensive Site Assessment (Law, 1993); Interim Remedial Action Remedial Investigation/Feasibility Study for Soil (Baker, 1994); Comprehensive Remedial Investigation Report (Baker, 1995a); and Interim Feasibility Study for Surficial Groundwater in the vicinity of the Former Fuel Farm (Baker, 1995b).

A comprehensive RI was conducted by Baker in 1994 to evaluate the nature and extent of the threat to public health and the environment caused by the release of hazardous substances, pollutants, or contaminants, and to support a Feasibility Study evaluation of potential remedial alternatives. The RI field program was initiated on April 11, 1994. Data gathering activities were derived from a soil gas survey and groundwater screening investigation, a soil investigation, a groundwater investigation, a surface water and sediment investigation to characterize the vertical and horizontal extent of fueland solvent-related contamination along the proposed IAS curtain boundary. This investigation consisted of installation and sampling of a total of 36 temporary monitoring wells. These wells were installed at 12 locations and as 3-well clusters designed to monitor the upper, middle, and lower regions of the surficial aquifer (see Figure 2-3).

Several areas of fuel- and solvent-related groundwater contamination were identified in the surficial aquifer in the area north of Fourth Street. Organic contaminant concentrations detected in the upper and lower portions of the surficial aquifer during the May 1994 sampling round, conducted by Baker, are shown in Figures 1-3 and 1-4, respectively. Additional figures depicting the nature and extent of groundwater contamination are provided in the Final RI Report (Baker, 1995a). A water table contour map indicating general groundwater flow directions in the surficial aquifer is provided in Figure 1-5. As shown in Figures 1-6 and 1-7, a hydrogeologic cross-section was developed for the area paralleling Brinson Creek which shows the various soil types for the area in which the IAS system was installed. An additional hydrogeologic cross-section was developed from the temporary well boring logs, which is provided in Appendix A. This cross-section indicates that the soil lithologies vary significantly between the southern and northern portions of the site. As shown in Appendix A, the surficial aquifer in the northern region north of temporary well TW-19 is comprised

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mainly of medium and fine-grained sands, whereas the region to the south of TW-19 contains at least one significant silt/clay lens of varying thickness.

Two additional areas of solvent-related groundwater contamination have been identified adjacent to Site 35. The extent and sources of this contamination have not been identified and additional RI activities are planned. In addition, significant levels of organic and inorganic contamination were identified in sediment samples.

Following the completion of the RI, a Final Interim Proposed Remedial Action Plan (PRAP) (Baker, 1995c) and Final Interim ROD for surficial groundwater at Site 35 were prepared (Baker, 1995d). These documents detailed five potential Remedial Action Alternatives (RAAs) developed in the FS for the remediation of organic chemical contaminated surficial groundwater at Site 35. More specifically, the following Remedial Action Objectives (RAOs) were developed in the FS for the surficial aquifer:

- Mitigate the potential for direct exposure to the contaminated groundwater in the surficial aquifer.
- Minimize or prevent the horizontal and vertical migration of contaminated groundwater in the surficial aquifer.
- Restore the surficial aquifer to the remediation levels established for the groundwater contaminants of concern.

The remediation levels established for the contaminants of concern are provided in Table 1-1. These levels were based on the NC DEHNR Water Quality Standards for Groundwater (15A NCAC 2L.0202).

RAA 5, In Well Aeration with Off-Gas Carbon Adsorption was selected in the Final Interim ROD contingent upon the successful execution of preliminary field pilot-scale tests. This RAA is interim in nature because it represents only one phase of a comprehensive investigation and remediation at Site 35 and is not intended to represent the final solution for OU No. 10. This particular interim action focuses on containment and remediation of organic groundwater contamination in the surficial aquifer located in the vicinity of the fuel farm and extending downgradient towards Brinson Creek. A remediation system installed in this area would be designed to mitigate the migration of groundwater contamination from OU No. 10 prior to its discharge into Brinson Creek.

Other media of concern such as sediment and groundwater in the upgradient portion of the surficial aquifer will be addressed during subsequent RI/FS activities that are scheduled to commence later this year. Soil contamination at Site 35 was excavated and removed as part of a separate Interim Remedial Action completed in the Spring of 1996.

The viability of in well aeration technology (RAA 5) at Camp Lejeune is being evaluated by means of a field pilot test currently underway at another site (OU No. 14, Site 69). Whether or not in well aeration is applied at Site 35 is dependent, in part, on the results of the field pilot test at Site 69. If it is determined, based on the results of the field pilot test, that in well aeration cannot perform as required, the Interim ROD (Baker, 1995d) indicated that RAA 3 (Groundwater Collection and On-Site Treatment) would be substituted as the Interim Preferred Remedial Action. To date, the field pilot test of in well aeration technology has experienced delays in being implemented at Site 69 which further delays field pilot-scale tests at Site 35. In the meantime, EPA, NC DEHNR, LANTDIV, Camp Lejeune, and Baker staff agreed that a treatability study of IAS technology would be appropriate at this site. If the results of this test are sufficiently positive, a request may be made to prepare an Explanation of Significant Differences (ESD) document to modify the selected alternative.

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## 2.0 OVERVIEW OF IN-SITU AIR SPARGING TECHNOLOGY

#### 2.1 Description

IAS is a technology in which air is bubbled through a contaminated aquifer. Air bubbles traverse horizontally and vertically through the soil column, creating an underground stripper that removes contaminants by volatilization and, for some contaminants, particularly fuel-related compounds, by biodegradation. The air bubbles carry the contaminants upward until they can be recovered by a vapor extraction system or released to the atmosphere.

IAS is a commercially available technology for removing volatile organic chemicals from groundwater. Various technical papers have been published documenting its effectiveness at sites across the U.S. In general, the available literature indicates that IAS is most frequently used to remediate shallow groundwater (i.e., less than 20 feet below the ground surface [bgs]); however, in theory there is no limit to its application.

At Site 35, the area east of the former fuel farm, between Brinson Creek and the proposed divided highway, is located, for the most part, within the limits of the Brinson Creek 100-year floodplain. The area is characteristically marshy with the groundwater surface generally situated within three feet of the ground surface throughout the year. This type of site does not avail itself to traditionally-applied vapor extraction due to the lack of a sufficiently thick unsaturated soil zone. Consequently, the contaminants removed from the shallow groundwater at Site 35 via IAS will be most likely discharged to the atmosphere directly.

#### 2.2 <u>Limitations</u>

The effectiveness of IAS system generally increases with increasing intrinsic permeability (k, cm<sup>2</sup>). Soils should have an intrinsic permeability of at least  $10^{-9}$  for air sparging to be effective (EPA/510/B-94/003). Silty sands generally have k values in the range of  $10^{-10}$  to  $10^{-8}$ . Therefore, the soils at Site 35, which are predominantly silty sands, are potentially amenable to IAS. Organic compounds with Henry's law constants greater than 0.01 atm-m<sup>3</sup>/mol (EPA/542/B-94/013) or 100 atm (EPA/510/B-94/003) are typically considered amenable to stripping. All of the VOCs of concern have Henry's constants that are greater than these values.

As previously indicated, IAS is generally applied to remediate contamination in shallow groundwater (i.e., less than 20 feet bgs). At Site 35, the area of contamination is distributed throughout a shallow groundwater zone that varies in depth from approximately 32 to 40 feet. Lighter molecular weight fuel contaminants are more prevalent near the groundwater surface, while heavier halogenated compounds are concentrated atop a semi-confining layer at the base of the shallow groundwater zone. In general, the lighter contaminants near the groundwater surface should be easier and less costly to remove than the heavier contaminants at the base of the shallow zone. This is due, in part, to the higher volatility of the lighter compounds and, in part, because of the greater energy required to inject air in the deeper zone.

The track record for IAS shows that it has indeed been applied more at sites contaminated with fuels rather than solvents. This is probably due in part to the larger number of fuel-related versus solvent-contaminated sites, the biodegradability of fuel-related contaminants, and the fact that the majority of fuel-related sites are characterized by contamination at or near the groundwater surface. IAS systems utilize injected air and are often combined with vapor extraction systems to control the migration of contaminants. At Site 35, between Brinson Creek and the proposed divided highway, the groundwater surface is generally within three feet of the ground surface throughout the year. The available unsaturated soil zone is insufficiently thick to afford the application of vapor extraction. Without vapor extraction, the migration of contaminants in the vadose zone is uncontrolled. However, as illustrated by the following example calculations, vapor emissions are anticipated to be low and should not pose an unacceptable risk to human health or the environment.

To provide a conservative estimate, or upper bound, of the vapor emission rate prior to performing the treatability study, it can be assumed that, at steady-state, the contaminant vapor emission rate will equal the dissolved contaminant migration rate to the IAS system. Thus, this upper bound can be calculated from an estimate of the groundwater specific discharge q [ft/d], width of the IAS barrier W [ft], the depth below the groundwater table to the injection point H [ft], and dissolved contaminant concentration  $C_{gw}$  [lb/ft<sup>3</sup>] as follows:

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 $Emissions_{max} = q [ft/d] \times W [ft/d] \times H [ft] \times C_{gw} [lb/ft^3]$ 

Based on the available Site 35 data from the RI Report, conservative estimates for these parameters are as follows: q = 0.06 ft/d (based on K = 0.001 cm/s, I = 0.02), W = 200 ft, H = 25 ft, C<sub>gw</sub> = 0.00006 lb/ft<sup>3</sup> ( $\approx 1,000 \ \mu g/L$ ). Inserting these values into the above emissions equation results in a maximum surficial emission rate of approximately 0.02 lb/d.

Assuming four sparging wells are installed over the 200-foot wide capture zone with a combined air flow rate of 40 cubic feet per minute (cfm) (i.e., four wells spaced 50 feet apart with 10 cfm per well), the resulting contaminant air concentration passing through the vadose zone would be  $3.5 \times 10^{-7}$  lb/ft<sup>3</sup> or 5.6 mg/m<sup>3</sup>. For a qualitative risk assessment, this value can be compared to the threshold limit value (TLV) for an 8-hour exposure (i.e., time-weighted average (TWA)) for benzene and TCE, which are 32 mg/m<sup>3</sup> and 269 mg/m<sup>3</sup>, respectively. Additional risk assessment analyses can be performed based on the air sampling results from the treatability study.

Another potential concern associated with the IAS system is the amount of contamination that will be retained in the soils (i.e., resulting contaminant concentrations) since implementation of a soil vapor extraction system to collect volatilized contaminants in the vadose zone may not be possible. Based on an vapor contaminant concentration of 5.6 mg/m<sup>3</sup> and assuming an equilibrium soil-vapor partitioning coefficient of 3.3 L/kg for benzene and 2.5 L/kg for TCE (see calculations provided in Appendix B), the degree of soil contamination resulting from this contaminated air is approximately 0.018 mg/kg for benzene and 0.014 mg/kg for TCE. The acceptable U.S. EPA risk-based concentrations (RBCs) for exposure to contaminated soil (i.e., accidental ingestion) under a residential use scenario are 22 mg/kg and 58 mg/kg for benzene and TCE, respectively. Thus, the IAS system should not create soil contamination that poses an unacceptable risk to human health or the environment.

## 2.3 Treatability Study Design Basis

The IAS alternative in the Interim FS (Baker, 1995b), Remedial Action Alternative (RAA) 4, included installation of an IAS "curtain," or barrier, to contain and treat contaminated groundwater as it flows towards Brinson Creek. The conceptual design for RAA 4 included a total of 43 sparging (i.e., air injection) wells spaced approximately 25 feet apart. As shown in Figure 2-1, a total capture zone approximately 1000 feet in width was assumed based on available data. The capture zone width was based on containing groundwater contaminated above the NC DEHNR-based groundwater

standards (Table 1-1). As shown in Figure 2-1, the sparging curtain is expected to be located approximately 25 feet downgradient, or east, of the highway's eastern right of way. A soil vapor extraction system was included in the FS as part of RAA 4, since it is typically required for an IAS system as a safeguard measure for controlling vapor emissions. RAA 4 was not selected because of the high water table conditions in the capture zone area along Brinson Creek.

One of the goals of the treatability study are to refine the conceptual design in the FS using test data as well as additional groundwater contaminant data obtained during the Supplemental Groundwater Investigation (SGI) at Site 35. The Draft SGI Report is scheduled to be submitted in November 1996. A summary of the available groundwater data through the 1994 RI for the fuel-related (i.e., benzene, toluene, ethylbenzene, and xylenes (BTEX)) and solvent-related (i.e., total chlorinated hydrocarbons (CHCs)) contamination in the vicinity of Brinson Creek is provided in Figure 2-2. Total concentrations of BTEX and CHCs detected during the April 1996 field investigation are shown in Figure 2-3.

Groundwater sampling results from the most recent field investigation and previous studies conducted by ESE (1990), NUS (1990), Law (1992 and 1993), and Baker (1994), indicate three primary areas of contamination that intercept the proposed sparging curtain boundary. Hypothetical contaminant plumes for these areas were developed (Figure 2-4) to estimate capture zones and to identify additional data needs. These plumes have been identified as plumes A, B, and C for purposes of this report. These plumes are considered hypothetical since it is unknown if each plume originates from a single source area or if it is actually a composite of two or more plumes originating The two northern plumes (A and B) represent BTEX contamination from multiple sources. associated with monitoring wells MW-20 and MW-16, respectively. The southern plume (plume C) consists of chlorinated solvent contamination, primarily TCE and 1,2-DCE, associated with monitoring well MW-19. A fourth potential area of solvent contamination (not shown), plume D, is located south of plume C near wells 35MW-34B, 35MW-35B, and 35MW-36B (see Figures 1-3 and 1-4). This zone of contamination does not appear to have encroached as near to Brinson Creek as plumes A, B, and C. The concentrations in plume D are three orders of magnitude less than the plume C contamination and appear to represent a separate contaminant source.

Of the three or four plumes intercepting the sparging curtain boundary, plumes B and C contain the bulk of the contaminant mass in the groundwater and pose the most risk to receptors in Brinson Creek. The significance of these two plumes with respect to the remedial design/action is discussed later in this section. Groundwater data (Figure 2-2) show that BTEX levels associated with plume A attenuate rapidly in the downgradient direction, suggesting natural attenuation mechanisms (i.e., biodegradation) are preventing appreciable contamination from reaching the creek. With respect to plume D, contaminant levels in this area only slightly exceed established cleanup levels. Therefore, with containment/treatment of the upgradient source area, natural attainment of the cleanup levels in plumes A and D may be possible through dilution and dispersion.

Conceptually, the shallow aquifer can be divided into two regions; an upper region in which the majority of the BTEX contamination resides, and a lower region that contains the bulk of the solvent-related contamination. The thickness of the shallow aquifer is approximately 30 to 35 feet, with the water table located approximately two to three feet bgs along the sparge curtain boundary. BTEX compounds were generally detected in the upper 0 to 15 feet of aquifer; whereas, the highest concentrations of chlorinated compounds were detected in the lower 20 to 35 feet of aquifer (i.e., above the semi-confining layer). BTEX concentrations in the upper aquifer are generally about two orders of magnitude higher in the upper aquifer than in the lower aquifer.

Plume B is generally a shallow BTEX plume with contamination in the center of the plume extending into the middle portion of the shallow aquifer (approximately 25 feet bgs) and contamination near the edges of the plume extending only to about 15 feet bgs. Plume B is approximately 300 feet in width. The centerline of the plume appears to be located near well TW-23. Soil conditions across Plume B appear more uniform compared to those across Plume C. Most of the saturated aquifer material across Plume B is composed of medium- and fine-grained sands. Thin silt/clay stringers were observed in some of the borings, however, the soils are predominantly sands.

In contrast to Plume B, Plume C is generally a deeper chlorinated solvent plume (mainly TCE and 1,2-DCE) with contamination generally absent in the upper 10 feet of aquifer and then increases dramatically with depth to the confining layer located 30-35 feet bgs. Plume C appears to be at least 450 feet in width. As shown in Figure 2-4, part of plume C overlaps with plume B. The highest concentrations of the TCE and 1,2 DCE contamination are centered near well locations TW-16 and TW-17. Soil boring logs from the wells installed along Plume C indicate a much more heterogeneous condition. Boring log TW-16 indicates either silty clay or clayey silt from 6.5 to 25 feet bgs. Silt and clay was also apparent in boring TW-17 down to 18.5 feet bgs with silty sand down to about 24.5 feet bgs. Borings TW-16 and TW-17 contained the highest concentrations of TCE and 1,2-DCE. The thicknesses of the silt/clay and clay/silt lenses appear to dramatically decrease in the northwestern direction along the sparge curtain boundary. A silt/clay lens was only detected from about 8.5 to 9.5 feet in boring TW-18.

Since plumes B and C essentially represent two distinct sites with different types of contamination and soils, two short-term (6-day) pilot-scale tests were proposed for Site 35, one for plume B and one for plume C. The treatability study for plume B was proposed to be conducted first since the soil lithology is more homogeneous and contains more sand and less silt than the aquifer materials located further south in the plume C area. Thus, prior to implementing the treatability study the plume B area appeared to be more conducive to IAS technology and had the greatest chance of success. If the plume B treatability study was determined to be successful (i.e., air can be effectively injected into the aquifer with no signs of entrapment below confining layers), then the plume C treatability study could also be performed. This area contains the highest levels of solvent-related contamination and poses the greatest treatment challenge with respect to IAS. It was anticipated that the scope of work for the plume C pilot test would be very similar to the first plume B pilot test. However, modifications and adjustments could be made to the plume C study based on data obtained and lessons learned from the first test.

To accommodate the two different types and zones of contamination, two sparging wells were proposed for the plume B treatability study, as shown in Figure 2-5. The upper sparging well would be screened approximately 14 to 16 feet bgs, whereas the lower sparging well would be screened from approximately 32 to 34 feet bgs. Exact screen placements were to be determined in the field based on actual conditions. As shown in Figure 2-6, only one deep sparging well was proposed for plume C because of the silt/clay and clay silt lenses present from approximately 7 to 23 feet bgs. Air injected into the plume C sparging well would be expected to travel horizontally within the lower sand layer and beneath the silt/clay lenses. The air would gradually travel upward as the silt/clay lenses become thinner and eventually disappear.

As shown in Figures 2-5 and 2-6, as the injected air exits the well screen and travels upward towards the water table, it fans out radially, forming a parabolic-shaped zone of influence (under homogeneous conditions). Soil heterogeneities, however, such as silt stringers or very permeable sand lenses, can dramatically alter this flow regime by trapping air and forcing it to move laterally and/or by creating preferential flow paths. Thus, changes in lithology may preclude the sparge curtain from treating certain zones of contamination. Because of the "fanning-out" effect, the length of the radius of influence (ROI) of a sparging well is typically least at the bottom of the well and greatest near the water table. Since the sparging wells cannot be placed below the semi-confining layer, chlorinated hydrocarbons located immediately above this layer may pass beneath and/or between the sparging wells. To minimize this problem, sparging wells may need to be tightly spaced in the deep zones of contamination (i.e., plume C). In areas with mainly shallow contamination, a longer spacing may be feasible, depending on lithology.

The results of the short-term treatability studies were expected to provide key information concerning the effectiveness and implementability of IAS technology at the Site 35 plumes. However, the short-term studies would not provide conclusive evidence as to the effectiveness of the sparge curtain to mitigate long-term contaminant migration. Furthermore, since the plume B treatability study would only be performed for a short duration, it could not provide data regarding potential enhancement of biodegradation rates in this area. For these reasons, a long-term (i.e., 12 to 18-month) barrier effectiveness test was proposed for plumes B and C, provided the short-term treatability study(s) yield(s) promising results. The long-term study would essentially represent the first phase of the interim remedial action, in which permanent, full-scale equipment and utilities would be installed by the Remedial Action Contract (RAC) contractor and operated at the site. During this period, new and existing monitoring wells located up-, down-, and cross-gradient of the sparge curtain boundary would be monitored to track contamination in both untreated and treated areas. Near the end of this time frame, one of the following decisions would be made based on sampling results:

- Continue operation of the existing system
- Expand the existing IAS system to include additional areas if necessary (e.g., plume A and/or plume D)
- Discontinue use of the sparging system in plume B and/or plume C in favor of an alternate technology (i.e., in-well aeration)

## 3.0 TREATABILITY STUDY OBJECTIVES

At Site 35 IAS is proposed as part of an interim remedial action. The focus of this interim action is the contaminated surficial groundwater in the area located east of the former Site 35 fuel farm, between Brinson Creek and the proposed divided highway. As this represents only a portion of the contaminated shallow groundwater identified at the site, this action is referred to as an Interim Remedial Action. That is, it represents only a portion of a more comprehensive investigation and remediation at Site 35 and will not necessarily be the final solution for OU No. 10.

The objectives of the treatability study are as follows:

- Assess the applicability of IAS technology in addressing shallow groundwater contamination at Site 35 by evaluating the effectiveness, implementability, and cost of a full-scale treatment system.
- Obtain sufficient data to afford the development of a full-scale system remedial design.
- Assess the impact of air emissions on human health and the environment, and verify that air emissions will not impact the proposed highway project.

## 4.0 MONITORING WELL AND SOIL GAS PROBE INSTALLATION

Groundwater monitoring wells and soil gas monitoring probes were installed to assist in monitoring the performance of the IAS system. This section describes the installation of the 26 monitoring wells and six soil gas monitoring probes at Plumes B and C.

#### 4.1 Monitoring Well Installation

This section describes the installation of the 14 monitoring wells at Plume B and the 12 monitoring wells at Plume C.

#### 4.1.1 Plume B

A total of 12 monitoring wells and 2 air injection wells were installed at Plume B from July 9 through July 14, 1996. The locations of the monitoring and air injection wells are shown on Figure 4-1. Drilling and well installation was performed by Parratt-Wolff, Inc. of East Syracuse, New York.

Subsurface soil samples were collected continuously during the drilling of monitoring wells 35MW-44B, 35MW-46A, 35MW-46B, 35MW-49A, and 35MW-50A to provide detailed subsurface stratigraphic information to depths ranging from approximately 12 to 35 feet below the ground surface (bgs). Subsurface soil samples were collected on five-foot centers during the drilling of monitoring wells 35MW-47B, 35MW-48B, 35MW-49B, and 35MW-50B to confirm subsurface stratigraphy to 31.5-feet (bgs). Subsurface soil samples were not collected from monitoring wells 35MW-45A, 35MW-45B, 35MW-47A, and 35MW-48A. Soil samples were obtained via two-foot long, two-inch diameter, split spoons. Standard penetration resistance values were obtained as per American Society for Testing Materials (ASTM) Method D 1586-84 and recorded on the boring logs. The samples were visually classified in the field using the Unified Soil Classification System (USCS). There were no environmental samples collected from the well borings during the monitoring well installation activities. Boring logs are provided in Appendix C.

Six of the monitoring wells (35MW-45A, 35MW-46A, 35MW-47A, 35MW-48A, 35MW-49A, and 35MW-50A) were installed to monitor the upper portion of the surficial aquifer with well screens set from two to 12 feet bgs. The other six monitoring wells (35MW-45B, 35MW-46B, 35MW-47B, 35MW-48B, 35MW-49B, and 35MW-50B) were installed to monitor the lower portion of the surficial aquifer with well screens set from 26 to 31 feet bgs. Wells 35MW-44A and 35MW-44B were installed to provide air injection points beneath the ground surface. All of the wells were constructed of two-inch diameter, schedule 40, polyvinyl chloride (PVC) casing with threaded joints and two-inch diameter, PVC well screens with No. 10-slot (0.01-inch) openings. The well screens were set at two feet bgs and extended to 12 feet bgs. The air injection well screens were set from 14 to 16 feet bgs and 32 to 34 feet bgs, respectively. A uniform sand pack with grains ranging between 0.01 and 0.03 inches in diameter was placed in the annulus around each well screen to approximately 0.5 to two feet above the top of the screen. A bentonite clay seal approximately 1.5 to two feet thick was placed atop the sand pack. A cement-bentonite slurry was used to fill the remaining annular space to the ground surface. The PVC well casings were set to stick-up above the ground surface approximately three feet. Protective steel casings with locking caps were placed over the PVC well casings and set into concrete collars. Well construction details are provided on Table 4-1.

The 12 monitoring wells and two air injection wells were developed to remove fines and stabilize the sand pack around the well screens establishing a hydraulic connection between the well and the watertable aquifer. A two-inch diameter centrifugal pump with a modified check valve and dedicated

black flex hose tubing was utilized for this purpose. Each well was pumped until the turbidity readings were less than 10 NTUs. The water in the well was surged with a surge block assembly for 20 minutes in an effort to loosen fines and reorient the sand grains in the sand pack into a tighter configuration.

Monitoring well 35MW-44B purged dry after one well volume (5.5 gallons). The well recharged at approximately 0.03 gallons per minute (gpm). An alternate well development method was used approximately two weeks after the initial attempt to develop the well. This method consisted of forcing compressed air into the well which pushes the water within the well out the top of the well. This method also failed to provide a good hydraulic connection between the well and the surficial aquifer. It is likely that the low productivity of this well was due to the small length (2 feet) well screen and/or a low hydraulic conductivity formation that the screen was set in.

#### 4.1.2 Plume C

A total of 11 monitoring wells and one air injection well were installed at Plume C from August 19 through August 29, 1996. The locations of the monitoring and air injection wells are shown on Figure 4-2. Drilling and well installation was performed by Parratt-Wolff, Inc. of East Syracuse, New York.

Subsurface soil samples were collected continuously during the drilling of monitoring well 35MW-51B to provide detailed subsurface stratigraphic information to a depth 31 feet bgs. Subsurface soil samples were collected on five-foot centers during the drilling of monitoring wells 35MW-52B, 35MW-53B, 35MW-54B, 35MW-55B, 35MW-56B, 35MW-57B, and 35MW-58B to confirm subsurface stratigraphy to depths ranging from 32 to 34 feet bgs. Only one subsurface soil sample was collected during the drilling of monitoring well 35MW-55A from a depth of five to seven feet bgs. Subsurface soil samples were not collected from monitoring wells 35MW-54A, and 35MW-53A. Soil samples were obtained via two-foot long, two-inch diameter, split spoons. Standard penetration resistance values were obtained as per ASTM Method D 1586-84 and recorded on the boring logs. The samples were visually classified in the field using the USCS. There were no environmental samples collected from the well borings during the monitoring well installation activities. Boring logs are provided in Appendix C.

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All of the monitoring wells were installed to monitor the portion of the surficial aquifer between the bottom of a clay layer and the top of the semi-confining unit. These wells were constructed of twoinch diameter, schedule 40, PVC casing with threaded joints and two-inch diameter, PVC well screens with No. 10-slot (0.01-inch) screen openings except for 35MW-51B. The tops of the well screens were set at depths ranging from seven to 24 feet bgs and extended to 12 to 31 feet bgs. Well 35MW-51B was installed to provide an injection point for the air to enter beneath the ground surface. This well was constructed of two-inch diameter, schedule 40, PVC casing with threaded joints and a two-inch diameter, PVC, continuous wound screen with 0.01-inch openings. This type of screen was utilized at this location to provide a larger area for the air to escape the injection well. The top of the well screen was set at 24 feet bgs and extended to 26 feet bgs. A uniform sand pack with grains ranging between 0.01 and 0.03 inches in diameter was placed in the annulus around the screens to approximately two to three feet above the top of the screen. A bentonite-clay seal approximately two to three feet thick was placed atop the sand pack. A cement-bentonite slurry was used to fill the remaining annular space to the ground surface. The PVC well casings were set to stick up above the ground surface approximately three feet. Protective steel casings with locking caps were placed over the PVC well casings and set into concrete collars. Well construction details are provided on Table 4-2.

The 11 monitoring wells and single air injection well were developed to remove fines and stabilize the sand pack around the well screens establishing a hydraulic connection between the well and the watertable aquifer. A two-inch diameter centrifugal pump with a modified check valve and dedicated black flex hose tubing was utilized for this purpose. Each well was pumped until a minimum of 10 well volumes were removed from the well and subsequent pH and conductivity readings stabilized. The water in monitoring well 35MW-55A was surged with a surge block assembly in an effort to loosen fines and reorient the sand grains in the sand pack into a tighter configuration.

## 4.2 Soil Gas Probe Installation

The intention of the soil gas probe installation was to provide vadose zone monitoring points to aid the evaluation of the effectiveness of the air sparging system. A total of six soil gas probes were installed at Plume B. The locations of the soil gas probes are shown on Figure 4-1.

The soil gas probes were constructed of one-inch diameter, schedule 40, PVC casing. All probes were five feet in length with a one-foot long well screen located at the end. The screen consisted of 0.1-inch slots spaced every 0.5-inches and 1/8-inch diameter holes spaced every 0.5-inches. The top of the probes were capped with a barbed fitting to allow for air samples to be obtained. Expendable drive points were placed on the end of the probes for installation purposes. Each probe was installed approximately 15 inches bgs. A bentonite seal was placed around the probe at the ground surface to mitigate air from being drawn into the probe from the atmosphere.

## 4.3 <u>Geology and Hydrogeology</u>

This section describes the local geologic and hydrogeologic conditions in the Plume B and Plume C areas. The discussion presented in this section is based primarily on the drilling observations made during the installation of 14 monitoring wells at Plume B and 12 monitoring wells at Plume C. Specific regional and site-wide geologic and hydrogeologic conditions are discussed in detail in the Final RI Report (Baker, 1995a) and the Final Treatability Study Work Plan (Baker, 1996).

#### 4.3.1 Plume B

The geologic conditions of the surficial aquifer local to the leading edge of Plume B were ascertained during the installation of 14 monitoring wells, 35MW-44A and B through 35MW-50A and B. The subsurface strata were logged during the installation of the deeper wells (wells with a "B" designation) to a maximum depth of 35 feet below ground surface. Boring logs are provided in Appendix C. The monitoring well locations in the Plume B area, as well as four cross section lines are shown on Figure 4-3. The four geologic cross sections are shown on Figure 4-4 through 4-7.

For the purposes of this treatability study, the subsurface strata in the Plume B vicinity were divided into four engineering geologic units, as follows:

Peat: The Peat material was encountered in every boring installed in the Plume B area from the ground surface to a depth below ground surface of approximately 9 to 11 feet. The material encompassed by this unit consists of dark brown peat with decomposed wood and roots. This material is typically extremely to very loose as illustrated by the split spoon blow counts recorded in the boring log as WOH (weight of hammer).

Sand: The sand unit was encountered in every boring installed in the Plume B area from depth of approximately 9 to 11 feet below the ground surface to a depth of 15 to 20 feet

below the ground surface. The sand unit is characterized as a dark brown to brown, very loose, fine grained sand with a trace silt and wood splinters/decomposed wood. As shown on Figures 4-6 and 4-7, the sand increases in thickness to the northeast.

Sand and Fossiliferous Limestone: This unit was encountered in each of the deep borings installed in the Plume B area from a depth of approximately 15 to 20 feet below the ground surface to 28.5 to 30 feet below the ground surface. This unit is characterized as a brown to yellow brown, medium dense fine to medium grained sand with some to little sandstone nodules, little cemented shell material/shell fragments and a trace silt. With depth, this unit grades to a light grey, medium dense to dense fossiliferous limestone with fine grained sand, little shell material/shell fragments and a trace silt.

Semi-Confining Unit: The semi-confining unit was encountered in each of the deep borings in the Plume B area at a depth of approximately 28.5 to 30 feet below the ground surface. The semi-confining consists of green grey, medium dense fine grained sand with a trace of silt, clay, shell material and fossiliferous limestone. This unit is distinctly more fine grained and compacted than the overlying sand and fossiliferous limestone unit. ک

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Each of these units appear to be generally flat lying and were laterally extensive with only minor lithologic variations over the Plume B IAS study area, as illustrated in the cross sections shown on Figures 4-4 through 4-7.

Groundwater was encountered at approximately 0.5 feet below the ground surface at each boring location to the total depth of each bore hole. Static groundwater elevations, collected after monitoring well installation and stabilization were not measured; therefore, the groundwater gradient (direction or magnitude) was not determined for the IAS study. However, based on the Final RI Report (Baker, 1995d), the groundwater flow in the Plume B area is to the northwest towards Brinson Creek.

The following generalizations may be made based on the Final RI Report, the Final Treatability Study Work Plan and observations during drilling and well development:

- Groundwater was first encountered near the ground surface in the peat unit and in each unit thereafter to the total depth of the borings. The entire surficial aquifer unit, down to the top of the semi-confining unit was saturated.
- Although substantial amounts of water were encountered in the surficial peat material, this unit was noted as having a low structural competence as implied by the standard penetration test WOH designation. The most productive, competent water bearing units in the surficial aquifer appear to be the sand, and sand and fossiliferous limestone units.
- The lowermost unit encountered at this site, the semi-confining unit displays a substantially lower permeability than the overlying units. This unit is typically considered a "marker bed" in the Camp Geiger area and acts as a hydrogeologic boundary, or a unit that retards vertical flow between the shallow, surficial aquifer and deeper aquifer systems. The top of the semi-confining unit constitutes the base of the surficial aquifer.

#### 4.3.2 Plume C

The geologic conditions of the surficial aquifer local to the leading edge of Plume C were ascertained during the installation of 12 monitoring wells, 35MW-51B through 35MW-58B. The subsurface strata were logged during the installation of the deeper wells (wells with a "B" designation) to a maximum depth of 34 feet below ground surface. Boring logs are provided in Appendix C. The monitoring well locations in the Plume C area, as well as three cross section lines are shown on Figure 4-8. The three geologic cross sections are shown on Figures 4-9 through 4-11.

For the purposes of this treatability study, the subsurface strata in the Plume C vicinity were divided into four primary engineering geologic units, as described in the following paragraphs.

- Silty Sand: Silty sand is the uppermost unit identified in the Plume C area and extends from the ground surface to depths of approximately 3 to 7 feet below the ground surface. The material encompassed by this unit consists of dark brown to brown, very loose fine grained sand with some to trace silt and little rooted/plant material.
- Clay: The clay unit was encountered in every boring in the Plume C area from depths of approximately 1 to 7 feet below the ground surface to 15 to 21 feet below the ground surface. Although this unit exhibited substantial lateral and vertical variability, it may be described in general terms for the purpose of this treatability study as a brown to grey, very soft to soft (plastic) sandy to silty clay. This unit also was characterized as moist, often with saturated overlying and underlying units.
- Sand: The sand unit was encountered in each of the deep borings/monitoring wells (designated with a "B") from depths of approximately 15 to 21 feet below the ground surface to 30 to 33.5 feet below the ground surface. Similar to the clay unit, the sand unit also displayed substantial lateral and vertical variability. In general, this unit consists of brown to light grey, loose to medium dense, fine to medium grain sand with traces of silt, sandstone nodules, and shell material/fragments. Locally (e.g., in the vicinity of 35MW-51B), this unit also contains fossiliferous limestone with fine grained sand and trace silt and cemented shell material/fragments.
- Semi-Confining Unit: This unit was encountered in each of the deep borings in the Plume C area at a depth of approximately 30 to 33.5 feet below the ground surface. The semi-confining unit consists of a green grey, medium dense fine grained sand with a trace of silt, clay, shell material and fossiliferous limestone. As in the Plume B area, this unit is distinctly more fine grained and compacted than the overlying sand unit.

The silty sand, sand and semi-confining units appear to be relatively flat lying and were laterally extensive over the Plume C IAS study area, as illustrated in the cross sections shown on Figures 4-9 through 4-11. The sand unit did increase in thickness in the northeast portion of the site in the vicinity of monitoring well 35MW-55B. The clay unit increased in thickness from approximately five feet in the northeast portion of the Plume C area (35MW-55B) to over 16 feet in the southwest portion of the area (35MW-58B) as illustrated on Figure 4-10. The decreasing clay thickness corresponded to an increasing sand unit thickness in the northeast portion of the area.

Groundwater was typically encountered in the sand unit underlying the clay at depths of 10 to 21 feet below the ground surface. Local wet zones (e.g., in monitoring well 35MW-51B) were encountered in the silty sand above the clay unit. Static groundwater elevations were not measured for the IAS study; therefore, the groundwater gradient (direction or magnitude) was not determined. However, based on the Final RI Report (Baker, 1995a), the groundwater flow in the Plume C area is to the northwest towards Brinson Creek.

The following generalizations may be made based on the Final RI Report, the Final Treatability Study Work Plan and observations during drilling and well development:

- The sand unit underlying the clay unit appears to be the principle water bearing unit in the surficial aquifer. Small amounts of water were noted in the silty sand above the clay unit.
- The clay unit appears to act as a partial hydraulic boundary and may retard both vertical and horizontal flow.
- The lowermost unit encountered at this site, the semi-confining unit appears to display a substantially lower permeability than the overlying sand unit. This unit is typically considered a "marker bed" in the Camp Geiger area and acts as a hydrogeologic boundary, or a unit that retards vertical flow between the shallow, surficial aquifer and deeper aquifer systems. The top of the semi-confining unit constitutes the base of the surficial aquifer.

The effect of these features on the effectiveness of the IAS study is discussed in Section 5.0.

## 5.0 TREATABILITY STUDY PROCEDURES AND OPERATION

The following sections describe the procedures and operation of the IAS treatability study at OU 10, Site 35, Plume B.

## 5.1 <u>Pre-Study Sampling</u>

Pre-study sampling was conducted for a duration of 24 hours prior to the start-up of the IAS system. The sampling consisted of monitoring soil gas and groundwater to establish a baseline set of physical and chemical data conditions in the vadose zone and surficial aquifer.

#### 5.1.1 Soil Gas Monitoring

Six soil gas probes were sampled prior to the start-up of the IAS system. The water table at Plume B was encountered just below the ground surface. At soil gas probe locations SG-1, SG-2, SG-3, and SG-6 no vadose zone was present to be monitored. Only soil gas probes SG-4 and SG-5 were installed in areas where a vadose zone was present.

Soil gas samples were obtained by pumping air from soil gas probes SG-4 and SG-5 for approximately 45 seconds utilizing a Dawson electric air sampling pump. All of the instruments used to monitor the air contained pumps to draw air from the probe into the instrument for analysis. Air samples were analyzed for percent oxygen, volatile organic compounds (VOCs), and pressure utilizing an  $O_2/LEL$  meter, photoionization detector (PID) and SUMMA canister, and magnehelic pressure gauges, respectively, as indicated in Table 5-1. Soil gas probes SG-1, SG-2, SG-3, and SG-6 were monitored for percent oxygen, VOCs, and pressure utilizing an  $O_2/LEL$  meter, PID, and magnehelic pressure gauges. These samples reflect only the ambient air from within the probes and not the air from the surrounding vadose zone. The high water table prohibited the use of the Dawson electric air sampling pump to obtain samples from the surrounding vadose zone at these locations.

#### 5.1.2 Groundwater Monitoring

Twelve groundwater monitoring wells were sampled prior to the start-up of the IAS system as indicated in Table 5-1. Dissolved oxygen readings were obtained from monitoring wells 35MW-45A/B, 35MW-46A/B, 35MW-47A/B, 35MW-48A/B, 35MW-49A/B, and 35MW-50A/B utilizing a YSI Model 55 Dissolved Oxygen meter. Groundwater samples were collected from monitoring wells 35MW-46A/B and 35MW-50A/B for analysis at a fixed-base laboratory for VOCs. Static water level readings were collected on a hourly basis from monitoring wells 35MW-45A/B, 35MW-45A/B, 35MW-46B, and 35MW-46B, and 35MW-45A/B, 35MW-46B, and 35MW-47A utilizing a Hermit data logger.

#### 5.2 Study Implementation

This section describes the IAS equipment utilized for the Plume B treatability study, the performance of the system, and the monitoring and sampling conducted during the study.

#### 5.2.1 In-Situ Air Sparging Equipment

The IAS equipment was constructed atop a flat bed trailer and consisted primarily of an oil-free rotary vane air compressor which was powered by a gasoline engine. The compressor was equipped with a pressure relief valve, check valve, and pressure gauge and was plumbed to one-inch diameter, schedule 40, steel pipe with a bleed valve to control air flow and a sampling port to monitor helium

concentrations in the air stream. Flow gauges and gate valves were located on the system to monitor and control the flow of air into the ground. Schedule 40, one-inch diameter, high temperature hose was used to connect the steel pipe to the injection well head. A process flow diagram depicting the equipment and instrumentation is provided on Figure 5-1.

## 5.2.2 In-Situ Air Sparging System Performance

The treatability study was comprised of two tests (deep and shallow air injection) each consisting of two phases (low and high flow rates). The first test injected air into the deeper zone at flow rates of approximately 7.5 and 20 actual cubic feet per minute (acfm) and air pressures of approximately 15.5 and 18.8 pounds per square inch (psi), respectively. The second test consisted of injecting air into the shallow zone at flow rates of approximately five and 20 acfm with corresponding air pressures of approximately seven and eight psi, respectively. The step from the lower flow rate to the higher flow rate did not occur until steady sate was obtained during the low flow phase. Table 5-2 presents the durations of each test phase and the associated flow rates. Helium was added to the air flow at a rate sufficient to yield a total helium concentration of approximately two to four percent of the air flow volume. A Mark 9822 Helium Detector was utilized to monitor the concentration of helium in the air stream.

#### 5.2.3 Study Sampling

Sampling during the treatability study consisted of monitoring soil gas and groundwater at the site to evaluate any changes to the baseline data collected during pre-test sampling. Table 5-3 presents the sampling conducted during the treatability study.

#### 5.2.3.1 Soil Gas Monitoring

Six soil gas probes were monitored during the operation of the IAS system. The water table at Plume B was encountered just below the ground surface. At soil gas probe locations SG-1, SG-2, SG-3, and SG-6 no vadose zone was present to be monitored. Only soil gas probes SG-4 and SG-5 were installed in areas where a vadose zone was present.

Soil gas samples were obtained by pumping air from soil gas probes SG-4 and SG-5 for approximately 45 seconds utilizing a Dawson electric air sampling pump. All of the instruments used to monitor the air contained pumps to draw air from the probe into the instrument for analysis. Air samples were analyzed for percent oxygen, VOCs, pressure, and helium utilizing an  $O_2$ /LEL meter, PID and SUMMA canister, magnehelic pressure gauges, and helium detector, respectively, as presented in Table 5-3. Soil gas probes SG-1, SG-2, SG-3, and SG-6 were monitored for percent oxygen, VOCs, pressure, and helium utilizing an  $O_2$ /LEL meter, HNU, magnehelic pressure gauges, and helium detector. These samples reflect only the ambient air from within the probes and not the air from the surrounding vadose zone. The high water table prohibited the use of the Dawson electric air sampling pump to obtain samples from the surrounding vadose zone at these locations.

#### 5.2.3.2 Groundwater Monitoring

Twelve groundwater monitoring wells were sampled during the operation of the IAS system as indicated in Table 5-3. Dissolved oxygen readings were obtained from monitoring wells 35MW-45A/B, 35MW-46A/B, 35MW-47A/B, 35MW-48A/B, 35MW-49A/B, and 35MW-50A/B utilizing a YSI Model 55 Dissolved Oxygen meter. Groundwater samples were collected from monitoring wells 35MW-46A/B and 35MW-50A/B for analysis at a fixed-base laboratory for VOCs.

Water levels were collected on a hourly basis from monitoring wells 35MW-45A/B, 35MW-46B, and 35MW-47A utilizing a Hermit data logger.

## 5.2.3.3 Groundwater Tracer Gas Monitoring

The fourteen groundwater monitoring wells at Plume B were monitored to detect the presence of helium. This monitoring was conducted to provide data regarding the zone of influence of the air injection well.

Modified slip caps were installed on the tops of the well casings to capture and monitor the ambient air inside the wells. The ambient air within the monitoring wells was analyzed for helium utilizing a helium detector. The frequency of this monitoring is shown in Table 5-3.

#### 5.3 <u>Post-Study Sampling</u>

Post-study sampling was conducted for a duration of 24 hours following the commencement of the study. The sampling consisted of monitoring soil gas and groundwater at the site as it returns to steady conditions. The sampling also monitored any changes to the baseline physical and chemical data conditions in the aquifer and vadose zone that may have occurred as a result of the treatability study.

#### 5.3.1 Soil Gas Monitoring

Six soil gas probes were monitored at the conclusion of the IAS study. The water table at Plume B was encountered just below the ground surface. At soil gas probe locations SG-1, SG-2, SG-3, and SG-6 no vadose zone was present to be monitored. Only soil gas probes SG-4 and SG-5 were installed in areas where a vadose zone was present.

Soil gas samples were obtained by pumping air from soil gas probes SG-4 and SG-5 for approximately 45 seconds utilizing a Dawson electric air sampling pump prior. The instrument used to monitor the air contained a pump to draw air from the probe into the instrument for analysis. Air samples were analyzed for VOCs and helium utilizing SUMMA canisters and a helium detector, respectively, as indicated in Table 5-4. Soil gas probes SG-1, SG-2, SG-3, and SG-6 were monitored for helium utilizing a helium detector. These samples reflect only the ambient air from within the probes and not the air from the surrounding vadose zone. The high water table prohibited the use of the Dawson electric air sampling pump to obtain samples from the surrounding vadose zone at these locations.

#### 5.3.2 Groundwater Monitoring

Twelve groundwater monitoring wells were sampled following the operation of the IAS system as indicated in Table 5-4. Dissolved oxygen readings were obtained from monitoring wells 35MW-44B, 35MW-45A/B, 35MW-46A/B, 35MW-47A/B, 35MW-48A/B, 35MW-49A/B, and 35MW-50A/B utilizing a YSI Model 55 Dissolved Oxygen meter. Groundwater samples were collected from monitoring wells 35MW-46A/B and 35MW-50A/B for analysis at a fixed-base laboratory for VOCs. Water levels were collected on a hourly basis from monitoring wells 35MW-45A/B, 35MW-46A, utilizing a Hermit data logger.

#### 6.0 TREATABILITY STUDY RESULTS

This section describes the results of the IAS treatability study. Dissolved oxygen in groundwater, ambient air helium concentrations, static water levels, groundwater analytical results, air sampling analytical results, and the radius of influence will be discussed and evaluated in the following sections. The percent oxygen, PID results, and pressure readings from the six soil gas probes did not indicate any effects from the treatability study. Therefore, this data will not be presented in this report. All of the data contained on the graphs and figures in this section which have been impacted by this IAS study have been color coded to assist in presenting the results of the treatability study (e.g., monitoring well 35MW-47A has been colored green on all the figures and graphs). This data evaluation will provide the necessary input to recommend a full-scale remedial system at Operable Unit No. 10, Site 35. Conclusions and design recommendations for the selection of a remediation system will be presented in Section 7.0.

Monitoring well 35MW-44B was intended to be the injection well for the deep injection test. Three separate attempts failed to inject air into the aquifer via 35MW-44B. Each attempt consisted of delivering approximately 20 psi of pressure into the well. The first attempt lasted for six hours while the second and third attempts consisted of 3-1/2 and three hours each, respectively. The steady state conditions within 35MW-44B were disturbed from these attempts of injecting air into the well. Therefore, the data obtained from this well was considered biased and was not discussed in this report. It is likely that the inability to inject air into the aquifer through this well was due to the small length (2 feet) of well screen and/or a low hydraulic conductivity formation that the screen was set in. As an alternative, monitoring well 35MW-47B was utilized as the injection well for the deep air injection portion of the treatability study.

The effectiveness of this treatability study was limited somewhat by the inability to inject air into 35MW-44B. One of the goals of the study was to inject air as close as possible to the top of the semiconfining unit due to the higher levels of contamination occurring in the deeper wells. This would have provided the ability to direct a greater volume of air through the areas of the highest contamination. This modification to the study influenced the data from the deeper monitoring wells. This was due to the fact that the monitoring wells were no longer in a position to intercept the air flow being injected from a deeper well. The performance of the study was, nevertheless, valid and provided the necessary input required for the performance-based design of a full-scale system.

#### 6.1 <u>Dissolved Oxygen</u>

The monitoring of dissolved oxygen (DO) in the groundwater assisted in evaluating the radius of influence from the treatability study. The DO readings indicated that the IAS system did impact the groundwater beneath the site. The discussion on the dissolved oxygen results has been divided between the shallow and deep monitoring wells as follows.

#### 6.1.1 Shallow Monitoring Wells

The pre-study or baseline DO readings for the shallow monitoring wells ranged from 0.14 to 0.25 milligrams per liter (mg/L) as presented in Table 6-1. An increase in DO was observed in the shallow monitoring wells during phase I (7.5 acfm) and phase II (20 acfm) of the deep air injection (35MW-47B) test and during phase II (20 acfm) of the shallow air injection (35MW-44A) test.

Three of the seven shallow monitoring wells (35MW-44A, 45A, and 47A) were influenced during phase I of the deep air injection test as indicated in Table 6-1. The increase in DO from these three

wells ranged from 0.82 to 10.91 mg/L. Four of the seven shallow monitoring wells (35MW-44A, 45A, 46A and 47A) were influenced during phase II of the deep air injection test as indicated in Table 6-1. The increase in DO from these four wells ranged from 0.92 to 11.71 mg/L. It should be noted that during the duration of the deep air injection test slugs of aerated groundwater were ejected from the top of 35MW-44A in a cyclic fashion. Therefore, it is assumed that the groundwater from this well was saturated with DO during the deep air injection test.

The DO readings declined during the post study between the deep and shallow air injection tests as shown on Figure 6-1. The decline in DO concentrations continued through phase I (5 acfm) of the shallow air injection test. The next increase in DO concentrations did not occur until phase II of the shallow air injection test. The DO increased from 0.67 to 6.35 mg/L in monitoring well 35MW-45A during phase II.

A plot of the DO concentrations from the shallow monitoring wells during the study are shown on Figure 6-1. Only sporadic data was obtained from monitoring well 35MW-44A due to the surging condition of the groundwater within the well, therefore it was not displayed on Figure 6-1. Three monitoring wells (35MW-44A, 45A, and 47A) were impacted during phase I of the deep air injection test yielding a radius of influence of approximately 20 feet as shown on Figure 6-2. Four monitoring wells (35MW-44A, 45A, 46A and 47A) were impacted during phase II of the deep air injection test yielding a radius of influence of approximately 20+ feet as shown on Figure 6-2. Only one monitoring well (35MW-45A) was impacted during phase II of the shallow air injection test yielding a radius of influence of approximately 20+ feet as shown on Figure 6-2. Only one monitoring well (35MW-45A) was impacted during phase II of the shallow air injection test yielding a radius of influence of approximately 10 feet as shown on Figure 6-3.

#### 6.1.2 Deep Monitoring Wells

The pre-study DO readings for the deep monitoring wells ranged from 0.13 to 0.25 milligrams per liter (mg/L) as presented in Table 6-2. An increase in DO was observed in a deep monitoring well during phase II (20 acfm) of the deep air injection (35MW-47B) test. No other changes in the DO concentrations occurred in the deep monitoring wells during the treatability study.

One of the seven deep monitoring wells (35MW-45B) was influenced during phase II of the deep air injection test as indicated in Table 6-2. This increase in DO occurred during one reading and ranged from 0.14 to 2.70 mg/L. This spike in DO indicated that the groundwater may have been impacted in a horizontal fashion more than what was expected at this site. A plot of the DO concentrations from the deep monitoring wells during the study are shown on Figure 6-4. It should be noted that the plotted DO concentration for 35MW-47B is residual DO from this well being utilized as the deep air injection well. These readings are not associated with the shallow air injection test.

### 6.2 <u>Helium</u>

Helium gas was utilized as a tracer element to monitor impacts, such as the radius of influence, that the IAS system had on the site. Helium was added to the air flow at a rate sufficient to yield a total helium concentration of approximately two to four percent. The helium readings indicated that the IAS system positively impacted the site.

#### 6.2.1 Shallow Monitoring Wells

The ambient air inside the wells was analyzed for helium utilizing a helium detector during the performance of the treatability study. The pre-study helium readings were zero as presented in Table 6-3. Helium was detected in the shallow monitoring wells during phase I (7.5 acfm) and phase II

(20 acfm) of the deep air injection (35MW-47B) test. Helium was also detected during phase I (5 acfm) and phase II (20 acfm) of the shallow air injection (35MW-44A) test. A plot of the helium concentrations detected in the ambient air from the monitoring wells during the study is provided on Figure 6-5.

Helium was detected in four shallow monitoring wells (35MW-44A, 45A, 46A, and 47A) ranging from 0.01 to 5.1 percent helium by volume during the deep air injection test as indicated in Table 6-3. The injected helium concentration by volume ranged from 0.8 to 6.0 percent during the deep air injection test. The concentrations of detected helium in the ambient air within the monitoring wells correlated well with the volume of helium being injected into the system. These results yielded an estimated radius of influence of approximately 20 feet for the deep air injection test as shown on Figure 6-2.

Helium was detected in one shallow monitoring well (35MW-45A) during the shallow air injection test as shown on Figure 6-5. The increase in helium occurred near the end of phase I and throughout phase II and ranged from 0.08 to 2.0 percent helium by volume during the shallow air injection test as shown on Table 6-3. These concentrations correlated well with the range of helium being injected (0.56 to 4.4 percent) into the air stream. This increase in helium yielded an approximate radius of influence of 10 feet as shown on Figure 6-3.

#### 6.2.2 Deep Monitoring Wells

Helium was not detected in any of the deep monitoring wells during the entire study as shown on Table 6-4. Therefore, the helium data indicated that the study did not impact the lower portion of the aquifer.

#### 6.2.3 Soil Gas Probes

Six soil gas probes were monitored for helium throughout the study. Helium was detected during phase I (7.5 acfm) and phase II (20 acfm) of the deep air injection (35MW-47B) portion of the study as shown on Figure 6-6. Helium was detected in SG-1 at concentrations ranging from 1.7 to 2.9 percent helium by volume during phase I and 0.71 to 1.0 percent helium by volume during phase II of the deep air injection test as indicated in Table 6-5. Soil gas probe SG-2 detected helium ranging from 0.01 to 0.04 percent helium by volume during phase II of the deep air injection test. Helium was not detected in any of the soil gas probes during the shallow air injection (35MW-44A) portion of the study.

The detection of helium in SG-1 yielded an approximate radius of influence of 20 feet during phase I and II of the deep air injection test. The detection of helium in SG-2 during phase II of the deep air injection test suggests that the radius of influence may have reached as far as 30 feet at a flow rate of 20 acfm from the deep air injection test.

#### 6.3 <u>Static Water Levels</u>

Static water levels were recorded in four monitoring wells throughout the site to monitor any influence the treatability study had on the water table aquifer utilizing data loggers. Monitoring wells 35MW-45A, 45B, 46B, and 47A were chosen to be monitored on a hourly basis during the pre-study, deep and shallow air injection tests, and post-study.

The treatability study impacted the water table aquifer beneath the site during the deep air injection test as shown on Figure 6-7. The greatest impact was noticed in the deep monitoring wells (35MW-45B and 46B) during the first few hours of each phase of the deep air injection test. Approximately half the magnitude of the impact from the deep wells was noticed by the shallow monitoring wells (35MW-45A and 47A). The large drop in the water level following the deep air injection test was likely due to a combination of the treatability study mounding the groundwater beneath the site and the immediate drop in pressure on the aquifer when the treatability study commenced. Once the injection of air into the aquifer commenced the water table formed a depression due to the lack of pressure combined with the groundwater discharging away from the site due to the mounding condition of the water table. The site recharged to its pre-study conditions within a few hours of the post study as shown on Figure 6-7.

Only a slight impact was noticed on the water table aquifer during the shallow air injection test. An increase of approximately 1/2 foot was noticed during the second phase of the shallow air injection test in monitoring well 35MW-47A as shown on Figure 6-7.

## 6.4 **Groundwater Analytical Results**

Groundwater samples were collected and analyzed for VOCs during each phase of the treatability study to determine if the study had an impact on the contaminants in the groundwater during the duration of the treatability study. The samples were collected from four monitoring wells, two shallow (35MW-46A and 50A) and two deep (35MW-46B and 50B). All of the samples were collected utilizing a peristaltic pump with dedicated tubing and were sent to a fixed-base laboratory for VOC analysis.

The groundwater samples were collected during the beginning of the pre-study, at the end of phase I and II of the deep and shallow injection tests, and during the post-study monitoring. No noticeable decline in site contaminants was noticed during the treatability study. The majority of the contaminants detected were chlorinated solvents such as chlorobenzene, 1,2-dichloroethene (total), and trichloroethene.

1,2-dichloroethene pre-study groundwater The samples detected chlorobenzene, (total). trichloroethene, and vinyl chloride ranging in concentrations from 1.2 J to 120 µg/L as presented in Table 6-6. The detected compounds during phase I of the deep air injection test consisted of benzene, 1,2-dichloroethene (total), trichloroethene, and vinyl chloride and ranged from 1.1 to 130 ug/L as indicated in Table 6-7. 1,2-dichloroethene (total), trichloroethene, and vinyl chloride were detected in the groundwater samples collected during phase II of the deep air injection test at concentrations ranging from 1.0 J to 99  $\mu$ g/L as presented in Table 6-8. The detected compounds during phase I of the shallow air injection test consisted of 1,2-dichloroethene (total), trichloroethene, and vinyl chloride and ranged from 1.0 J to 120  $\mu$ g/L as indicated in Table 6-9. Benzene, chlorobenzene, 1,2-dichloroethene (total), methylene chloride, and trichloroethene were detected in the groundwater samples collected during phase II of the shallow air injection test at concentrations ranging from 1.0 J to 130 µg/L as presented in Table 6-10. The post-study groundwater samples detected 1,2-dichloroethene (total) and trichloroethene ranging in concentrations from 1.2 J to 130  $\mu$ g/L as presented in Table 6-11.

The concentrations of the detected compounds varied slightly from each phase of the tests. The minor changes did not indicate any influence on the contaminants in the groundwater from the short duration of the treatability study. A noticeable impact may have been observed on the monitoring

wells sampled if the radius of influence from the treatability study would have encompassed these monitoring wells.

#### 6.5 <u>Air Sampling Analytical Results</u>

A total of 12 air samples were collected during the duration of the treatability study via SUMMA canisters to evaluate any contaminants which may have been released to the ambient air of the site and within the vadose zone. Eight of the samples (SUMMA canister ID # 0048, 12586, 0169, 93279, 12403, 93040, 0039, and 92039) were collected from soil gas probes SG-4 and SG-5 to monitor the vadose zone. The remaining four samples (SUMMA canister ID # 04330, 92003, 12544, and 93148) consisted of ambient air and were obtained in the vicinity of the two air injection wells and the IAS trailer location. All of the samples were analyzed for TO-14 at a fixed-based laboratory. The air sampling locations and corresponding SUMMA canister ID numbers are shown on Figure 6-8. The detected analytical results are displayed in Table 6-12 and an evaluation of the analytical results is provided in the following paragraphs.

The following section presents a qualitative comparison of Plume B air sampling data collected for the IAS treatability study to human health risk-based criteria. The purpose of this qualitative risk evaluation is to determine if there is a potential for adverse health effects to occur in the absence of collecting the off-gas from the IAS technology. Therefore, only the data from the four ambient air samples were compared to relevant risk-based criteria and discussed qualitatively.

Under the IAS treatability study, four ambient air monitoring samples were analyzed for volatile organic compounds (VOCs). Table 6-12 presents the VOCs detected in the ambient air monitoring samples. The positive detections were compared qualitatively to USEPA Region III Ambient Air Risk-Based Concentrations (RBCs). All detected VOCs are retained for further consideration. M-Xylene, p-xylene, toluene, tetrachloroethene, cis-1,2-dichloroethene, chloromethane, carbon disulfide, and dichlorodifluoromethane were detected at maximum concentrations below their respective ambient air RBCs. N-Butane and pentane were also detected. However, it should be noted that there were no risk-based criteria established for n-butane and pentane.

Benzene was detected in one out of four samples at a detected concentration exceeding the ambient air RBC. However, this detection of benzene was only detected in one of the four samples and seems to be isolated. Consequently, this suggests that the potential for adverse health effects to occur during the operation of an IAS treatment system would be unlikely.

#### 6.6 <u>Radius of Influence</u>

The treatability study was operated at two flow rates during the shallow and deep air injection tests to determine an optimum flow rate and a corresponding radius of influence for the in-situ air sparging technology at this site. The radius of influence and corresponding flow rates will be discussed in the following sections and will be split between the deep air injection test and the shallow air injection test.

#### 6.6.1 Deep Air Injection Test

The deep air injection test provided valuable data for evaluating the radius of influence and determining the optimum flow rate for Site 35. The deep air injection test utilized monitoring well 35MW-47B for the air injection location. Air was injected at two different flow rates (7.5 and 20 acfm) as shown on the system head curve (Figure 6-9).

An approximate radius of influence of 20 feet was observed during phase I (7.5 acfm) of the deep air injection well (35MW-47B) as indicated by the supporting data obtained from the monitoring wells and soil gas probes previously discussed. The monitoring well data indicated a radius of influence greater than 20 feet for phase II (20 acfm) of the deep air injection test. The soil gas data indicated a radius of influence of approximately 30 feet for the same phase. It was estimated that injecting air approximately 26 feet bgs at 20 acfm will yield a radius of influence of approximately 25 feet away from the sparge point. Three geologic cross-sections have been developed to assist in visualizing the approximate radius of influence from the IAS system. Figure 6-10 shows the locations of the geologic cross sections for Plume B. Figures 6-11, 6-12, and 6-13 provide three different cross sections of the site. The monitoring points which were impacted during the pilot test have been displayed in color.

#### 6.6.2 Shallow Air Injection Test

The shallow air injection test provided valuable data for evaluating the radius of influence and determining the optimum flow rate for Site 35. The shallow air injection test utilized monitoring well 35MW-44A for the air injection location. Air was injected at two different flow rates (5 and 20 acfm) as shown on the system head curve (Figure 6-14).

A radius of influence was not observed during phase I (5 acfm) of the shallow air injection test as indicated by the supporting data obtained from the monitoring wells and soil gas probes previously discussed. The monitoring well data indicated a radius of influence of approximately 10 feet for phase II (20 acfm) of the shallow air injection test. This radius of influence did not sustain the entire 24 hour period that the system was operating during this phase. This was most likely due to the subsurface stratigraphy in which the shallow air injection well was located. This stratigraphy consisted mainly of peat material. The air pathways which were developing early during phase II failed to sustain themselves due to the poor shear strength associated with this peat material located in the first 12 feet bgs. Three geologic cross-sections have been developed to assist in visualizing the approximate radius of influence from the IAS system. Figure 6-10 shows the locations of the geologic cross sections for Plume B. Figures 6-15, 6-16, and 6-17 show three different cross sections of the site. The monitoring points which were impacted during the pilot test have been displayed in color.

#### 6.7 Additional Groundwater Sample Results

An additional round of post-test groundwater samples were collected from four monitoring wells at Plume B during October 1996. These samples were collected to determine if any significant changes to the groundwater contamination has occurred since the completion of the pilot test and also as a follow up to the lack of BTEX contamination in this area compared to the contamination upgradient. Four groundwater samples were collected from Plume C to assist in evaluating the extent of the contamination at Site 35. This data was valuable in recommending an IAS system for Site 35.

The groundwater analytical results did not indicate any significant changes in the contaminants at Plume B when compared to the previous data collected from Plume B during the treatability study. 1,2-Dichloroethene and trichloroethene were detected at concentrations ranging from 12 to 160  $\mu$ g/L as presented in Table 6-14. These concentrations correlated well with the analytical results from the previous treatability study sampling conducted in August 1996.

Additional groundwater samples were collected from a few monitoring wells upgradient of the IAS treatability study location. It was in these wells that significant groundwater contamination was

detected in the surficial aquifer prior to the soil removal action at the former fuel farm location. The levels of BTEX from the samples collected during October 1996 were an order of magnitude less than those samples collected prior to the soil removal. Therefore, it is believed that the decline in the BTEX contamination at the site may be somewhat attributed to the removal of the contaminated soil.

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The analytical results from the groundwater collected at plume C detected similar compounds from Plume B but at increased concentrations. The concentrations of the compounds detected ranged from 23 to 1400  $\mu$ g/L as indicated in Table 6-15. The contamination in the deep wells was significantly greater than the contamination in the shallow wells.

#### 7.0 CONCLUSIONS AND RECOMMENDATIONS

This section provides the conclusions from the IAS treatability study and recommendations for the design of a full-scale IAS system. These conclusions and recommendations are supported by the information in Sections 1.0 through 6.0 of this report.

#### 7.1 <u>Conclusions</u>

Based on the results of the IAS treatability study it can be concluded that:

- IAS via vertical air injection will have limited effectiveness remediating CHCs at the base of the surficial aquifer. The semi-confining unit is too impermeable to allow air injection below the base of the surficial aquifer and underneath the contaminants.
- Vertical air injection in the area of the Plume C treatability study wells is inappropriate due to the presence of a subsurface clay layer. This clay layer will inhibit the vertical release of contaminants to the atmosphere and may result in the horizontal migration of contaminants off site.
- Results of groundwater sampling indicate BTEX contamination is not present in the area of the Plume B or Plume C wells. There are three possible reasons for the lack of contamination at these locations:
  - 1) The source of the contamination has been removed during the previous soil removal action at the former fuel farm.
  - 2) The contamination has not migrated to the IAS treatability study location.
  - 3) The contamination is being naturally attenuated in the approximately 10foot thick peat bog located along the banks of Brinson Creek.
- Vertical air injection from the deep air injection wells did have a favorable impact at Plume B. A radius of influence of 20 feet was observed at a flow rate of 7.5 acfm. The radius of influence increased to approximately 30 feet when the air flow was increased to 20 acfm.
- Vertical air injection from the shallow air injection wells did not have a favorable impact at Plume B. Due to the lack of shear strength of the peat material, air pathways were unable to be developed and sustained from an air injection point just below the peat layer.
- Due to BTEX results, IAS, if implemented in the area between the eastern edge of the proposed right-of-way and Brinson Creek, will not impact the BTEX contamination.

### 7.2 <u>Recommendations</u>

- An IAS system where air is injected horizontally along the top of the semi-confining layer is preferable to conventional vertical air injection. Such a system should be more effective in remediating the CHC and BTEX contamination at this site. It is estimated that the cost of this system should be approximately equal to RAA 3, Groundwater Collection and On-Site Treatment, which was identified as the preferred contingent alternative in the Final Interim ROD (Baker, 1995).
- Due to poor site conditions, difficult access, and a lack of BTEX contamination in groundwater in the area between the eastern edge of the proposed right-of-way and Brinson Creek, an IAS system will likely be more effective if constructed along the western edge of the proposed right-of-way as shown on Figure 7-1.
- A field pilot test of a horizontal IAS system should be conducted in the area west of the proposed right-of-way to ensure it's effectiveness prior to full-scale implementation.

#### 8.0 **REFERENCES**

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#### TABLE 1-1

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# ORGANIC COCs THAT EXCEED REMEDIATION LEVELS IAS TREATABILITY STUDY OPERABLE UNIT NO. 10 (SITE 35) CAMP LEJEUNE, NORTH CAROLINA

Contaminant of Concern	RL <sup>(1,2)</sup>	Basis of RL
Benzene	1	NC WQS
Trichloroethene	2.8	NC WQS
cis-1,2-Dichloroethene	70	NC WQS
trans-1,2-Dichloroethene	70	NC WQS
Ethylbenzene	29	NC WQS
Methyl Tertiary Butyl Ether	200	NC WQS
Xylenes	530	NC WQS

Notes:

<sup>(1)</sup> RL = Remediation Level

<sup>(2)</sup> Groundwater RLs expressed as  $\mu$ g/L (ppb)

NC WQS = North Carolina Water Quality Standard

### TABLE 4-1

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### MONITORING WELL CONSTRUCTION DETAILS - PLUME B IAS TREATABILITY STUDY OPERABLE UNIT NO. 10 (SITE 35) CAMP LEJEUNE, NORTH CAROLINA

		<u></u>		Screened	Interval	
Well Number	Completion Date	Ground Surface Elevation (feet MSL)	Top of PVC Casing Elevation	Depth (feet bgs)	Elevation (feet MSL)	Total Depth of Well (feet bgs)
35MW-44A	7/11/96	2.8	5.76	14 - 16	-11.213.2	16.2
35MW-44B	7/14/96	2.8	5.35	32 - 34	-29.231.2	34.2
35MW-45A	7/11/96	2.8	5.46	2 - 12	0.89.2	12.5
35MW-45B	7/14/96	2.8	5.60	26 - 31	-23.228.2	31.5
35MW-46A	7/9/96	2.4	5.26	2 - 12	0.49.6	12.5
35MW-46B	7/9/96	2.8	5.74	26 - 31	-23.228.2	31.5
35MW-47A	7/10/96	2.6	5.49	2 - 12	0.69.4	12.5
35MW-47B	7/10/96	2.8	5.77	26 - 31	-23.228.2	31.5
35MW-48A	7/10/96	2.3	5.20	2 - 12	0.39.7	12.5
35MW-48B	7/11/96	2.4	5.13	26 - 31	-23.628.6	31.5
35MW-49A	7/10/96	2.4	4.99	2 - 12	0.49.6	12.5
35MW-49B	7/10/96	2.3	4.98	26 - 31	-23.728.7	31.5
35MW-50A	7/11/96	2.6	5.37	2 - 12	0.69.4	12.5
35MW-50B	7/11/96	2.9	5.45	26 - 31	-23.128.1	31.5

### TABLE 4-2

### MONITORING WELL CONSTRUCTION DETAILS - PLUME C IAS TREATABILITY STUDY OPERABLE UNIT NO. 10 (SITE 35) CAMP LEJEUNE, NORTH CAROLINA

				Screened	Interval	
Well Number	Completion Date	Ground Surface Elevation (feet MSL)	Top of PVC Casing Elevation	Depth (feet bgs)	Elevation (feet MSL)	Total Depth of Well (feet bgs)
35MW-51B	8/21/96	2.5	5.20	24 - 26	-21.523.5	31
35MW-52A	8/24/96	3.1	5.91	18 - 23	-14.9 <b></b> 19.9	23
35MW-52B	8/24/96	3.0	5.88	22 - 27	-19.024.0	32
35MW-53A	8/26/96	3.3	6.39	15.5 - 20.5	-12.217.2	21
35MW-53B	8/25/96	3.0	6.31	22 - 27	-19.0 <b>2</b> 4.0	32
35MW-54A	8/25/96	3.3	6.36	18 - 23	-14.7 <b></b> 19.7	23
35MW-54B	8/25/96	3.2	6.25	22 - 27	-18.823.8	32
35MW-55A	8/24/96	2.3	5.07	7 - 12	-4.79.7	12
35MW-55B	8/23/96	2.9	6.09	21 - 26	-18.123.1	32
35MW-56B	8/23/96	6.3	8.99	15 - 25	-8.718.7	34
35MW-57B	8/22/96	2.8	5.74	17 - 27	-14.224.2	32
35MW-58B	8/26/96	6.9	9.97	21 - 31	-14.124.1	32

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### PRE-STUDY SAMPLING MATRIX - PLUME B IAS TREATABILITY STUDY OPERABLE UNIT NO. 10 (SITE 35) CAMP LEJEUNE, NORTH CAROLINA

Matrix	Location	Analysis	Frequency	Method	Total Samples
Soil Gas	All probes	Oxygen	t - 0	O <sub>2</sub> /LEL	6
Soil Gas	All probes	VOCs	t = 0	Vapor analyzer	6
Soil Gas	SG4, SG5	VOCs	t = 0	SUMMA, TO-14	2
Soil Gas	All probes	Pressure	t = 0	Pressure gauge	6
Groundwater	All wells except 44A/B	D.O.	t = 0	D.O. meter	12
Groundwater	46A/B, 50A/B	VOCs	t = 0	Lab, SW 846 8240	4
Groundwater	45A/B, 46B, 47A	Water Level	Hourly	Data Logger	96

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### TEST PHASE DURATIONS - PLUME B IAS TREATABILITY STUDY OPERABLE UNIT NO. 10 (SITE 35) CAMP LEJEUNE, NORTH CAROLINA

Task Name	Wed Aug 7	Thu Aug 8	Fri Aug 9	Sat Aug 10	Sun Aug 11	Mon Aug 12	Tue Aug 13	Wed Aug 14
Pre Study Sampling								
Deep Well Air Injection Phase I (7.5 acfm)								
Deep Well Air Injection Phase II (20 acfm)					•			
Post Study Sampling								
Shallow Well Air Injection Phase I (5 acfm)								
Shallow Well Air Injection Phase II (20 acfm)								
Post Study Sampling								

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### TREATABILITY STUDY SAMPLING MATRIX - PLUME B IAS TREATABILITY STUDY OPERABLE UNIT NO. 10 (SITE 35) CAMP LEJEUNE, NORTH CAROLINA

Matrix	Location	Analysis	Frequency	Method	Total Samples
Deep Air Injection					
Soil Gas	All probes	Oxygen	t = 4,18,22,42	O2/LEL	24
Soil Gas	All probes	VOCs	t = 4,18,42	Vapor analyzer	18
Soil Gas	SG4, SG5	VOCs	t = 18,42	SUMMA, TO-14	4
Soil Gas	All probes	Pressure	t = 4,18,22,24,42	Pressure gauge	30
Soil Gas	All Probes	Helium	t = 4,18,22,24,42	Helium Detector	30
Groundwater	All wells except 44A/B	D.O.	t = 2,4,17,21,24,26,41	D.O. meter	84
Groundwater	46A/B, 50A/B	VOCs	t = 19,44	Lab, SW 846 8240	8
Groundwater	45A/B, 46B, 47A	Water Level	Hourly	Data Logger	176
Groundwater Off-Gas	All Wells	Helium	t = 4,6,17,22,24,27,30,41	Helium Detector	112
Shallow Air Injection					
Soil Gas	SG4, SG5	VOCs	t = 23,25,48	SUMMA, TO-14	6
Soil Gas	All Probes	Helium	t = 3,9,23,27,30,33,47	Helium Detector	42
Groundwater	All wells except 44A/B	D.O.	t = 0,2,5,8,24,27,30,33,47	D.O. meter	108
Groundwater	46A/B, 50A/B	VOCs	t = 24,48	Lab, SW 846 8240	8
Groundwater	45A/B, 46B, 47A	Water Level	Hourly	Data Logger	192
Groundwater Off-Gas	All Wells	Helium	t = 3,5,9,23,26,30,33,47	Helium Detector	112

### POST-STUDY SAMPLING MATRIX - PLUME B IAS TREATABILITY STUDY OPERABLE UNIT NO. 10 (SITE 35) CAMP LEJEUNE, NORTH CAROLINA

Matrix	Location	Analysis	Frequency	Method	Total Samples
Deep Air Injection					
Groundwater	All wells except 44A/B	D.O.	t = 2,6,10,23	D.O. meter	48
Groundwater	45A/B, 46B, 47A	Water Level	Hourly	Data Logger	96
Shallow Air Injection					·
Soil Gas	All Probes	Helium	t = 4,8,22	Helium Detector	18
Soil Gas	SG4, SG5	VOCs	t = 22	SUMMA, TO-14	2
Groundwater	All wells except 44A/B	D.O.	t = 4,8,22	D.O. meter	36
Groundwater	46A/B, 50A/B	VOCs	t = 22	Lab, SW 846 8240	8
Groundwater	45A/B, 46B, 47A	Water Level	Hourly	Data Logger	96
Groundwater Off-Gas	All Wells	Helium	t = 4,8,22	Helium Detector	42

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### SHALLOW MONITORING WELL DISSOLVED OXYGEN CONCENTRATIONS - PLUME B IAS TREATABILITY STUDY OPERABLE UNIT NO. 10 (SITE 35) CAMP LEJEUNE, NORTH CAROLINA

Test	Phase	Flow Rate (acfm)	Time (hours)	44A	45A	46A	47A	48A	49A	50A
Pre-Study		0	0	NA	0.25	0.20	0.14	0.14	0.15	0.20
Deep	I	7.5	2	NA	2.60	0.19	4.88	0.29	0.15	0.23
Air			4.5	NA	1.18	0.30	5.82	0.18	0.29	0.49
Injection			17	_10.91	0.82	0.25	8.21	.0.14	0.12	0.26
	II	20	2.5	NA	0.71	0.98	9.50	0.29	0.31	0.18
			5	NA	1.62	0.93	9.70	0.36	0.25	0.28
			7	NA	5.98	1.23	9.33	0.31	0.20	0.32
			22	NA	2.65	0.92	11.71	0.25	0.23	0.30
Post			2	12.17	4.41	7.33	7.27	NA	NA	NA
Study			6	11.58	2.38	4.40	5.54	NA	NA	NA
			10	9.35	2.01	0.50	4.61	NA	NA	NA
Shallow	I	5	0	4.46	1.75	0.28	2.92	0.28	0.31	0.28
Air			2	NA	1.72	0.17	3.11	0.24	0.24	0.17
Injection			5	NA	1.70	0.18	2.85	0.36	0.26	0.23
-			8	NA	1.57	0.18	2.30	0.21	0.29	0.25
			23	NA	0.67	0.10	1.88	0.18	0.16	0.07
	II	20	2	NA	5.18	0.13	2.10	0.07	0.20	0.04
			5	NA	5.50	NA	2.27	NA	NA	NA
			8	NA	6.35	0.20	1.89	0.15	0.15	0.13
			23	NA	5.78	0.16	1.75	0.20	0.21	0.13
Post		0	4	NA	1.66	0.19	1.56	0.22	0.19	0.23
Study			8	NA	2.07	0.16	1.60	0.15	0.24	0.16
			24	NA	1.78	0.22	1.43	0.05	0.35	0.14

Notes: NA - Not analyzed

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### DEEP MONITORING WELL DISSOLVED OXYGEN CONCENTRATIONS - PLUME B IAS TREATABILITY STUDY OPERABLE UNIT NO. 10 (SITE 35) CAMP LEJEUNE, NORTH CAROLINA

Test	Phase	Flow Rate (acfm)	Time (hours)	44B	45B	46B	47B	48B	49B	50B
Pre-Study		0	0	NA	0.25	0.23	0.16	0.15	0.13	0.22
Deep Air	I	7.5	2	NA	0.12	0.19	NA	0.14	0.16	0.21
Injection			4.5	NA	0.26	0.30	NA	0.15	0.28	0.16
		17	NA	0.11	0.14	NA	0.18	0.13	0.36	
	II	20	2.5	NA	0.14	0.18	NA	0.18	0.17	0.14
			5	NA	0.17	0.16	NA	0.14	0.21	0.33
			7	NA	2.70	0.17	NA	0.25	0.21	0.23
			22	NA	0.16	0.13	NA	0.22	0.24	0.27
Post			2	NA	NA	NA	NA	NA	NA	NA
Study			6	NA	NA	NA	NA	NA	NA	NA
			10	NA	NA	NA	NA	NA	NA	NA
Shallow	I	5	00	4.75	0.18	0.23	8.55	0.19	0.10	0.12
Air Injection			2	4.00	0.18	0.16	5.88	0.18	0.16	0.23
ngoodon			5	3.31	0.18	0.18	4.26	0.15	0.17	0.21
			8	3.10	0.19	0.17	2.85	0.14	0.15	0.18
			23	2.75	0.11	0.14	2.21	0.13	0.14	0.15
	II	20	2	2.40	0.19	0.12	0.52	0.30	0.08	0.09
			5	4.58	0.20	NA	NA	NA	NA	NA
			8	1.81	0.18	0.22	0.13	0.16	0.20	0.11
			23	1.78	0.15	0.18	0.15	.0.14	0.14	0.12
Post		0	4	1.54	0.17	0.16	0.16	0.17	0.17	0.22
Study			8	1.59	0.22	0.23	0.14	0.10	0.13	0.23
			24	1.55	0.17	0.26	0.15	0.05	0.13	0.22

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Notes: NA- Not analyzed

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### SHALLOW MONITORING WELL PERCENT HELIUM BY VOLUME - PLUME B IAS TREATABILITY STUDY OPERABLE UNIT NO. 10 (SITE 35) CAMP LEJEUNE, NORTH CAROLINA

Test	Phase	Flow Rate (acfm)	Time (hours)	44A	45A	46A	47A	48A	49A	50A
Pre-Study		0	0	0	0	0	0	0	0	0
Deep Air	I	7.5	2	NA	2.60	0.01	4.60	0	0	0
Injection			4.5	NA	3.10	0.40	4.20	0	0	0
			17	0.82	1.20	0	5.10	0	0	0
ĺ	II	20	2.5	0.15	2.20	1.50	1.70	0.02	0	0
			5	0.35	2.00	1.80	2.00	0.02	0	0
			7	0	1.50	1.00	1.60	0	0	0
			11	0.07	0.38	0.21	1.60	0	0	0
			22	0.08	1.60	1.30	1.60	0	0	0
Post			2	NA	NA	NA	NA	NA	NA	NA
Study			6	NA	NA	NA	NA	NA	NA	NA
			10	NA	NA	NA	NA	NA	NA	NA
Shallow	I	5	2	<u>NA</u>	0.17	0.01	0.27	0	0	0
Air			5	NA	0.10	0	0.18	0	0	0
Injection			8	NA	0.08	0	0.17	0	0	0
			23	NA	1.00	0	0.10	0	0	0
	II	20	2	NA	1.90	0	0.06	0	0	0
			5	NA	0.88	0	0.08	0	0	0
			8	NA	2.00	0	0.08	0	0	0
			23	NA	1.50	0	0.08	0	0	0
Post		0	4	0	0.81	0	0.10	0	0	0
Study			8	0	0.56	0	0.09	0	0	0
			24	0	0	0	0	0	0	0

Notes: NA- Not analyzed

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### DEEP MONITORING WELL PERCENT HELIUM BY VOLUME - PLUME B IAS TREATABILITY STUDY OPERABLE UNIT NO. 10 (SITE 35) CAMP LEJEUNE, NORTH CAROLINA

Test	Phase	Flow Rate (acfm)	Time (hours)	44B	45B	46B	47B	48B	49B	50B
Pre-Study		0	0	0	0	0	0	0	0	0
Deep Air	I	7.5	2	NA	0	0	NA	0	0	0
Injection			4.5	NA	0	0	NA	0	0	0
			17	0	0	0	NA	0	0	0
	II	20	2.5	0	NA	NA	NA	NA	NA	0
			5	0	0	0	NA	0	0	0
			7	0	0	0	NA	0	0	0
		4	11	0_	_0	0	NA	0	0	0
			22	.0	0	0	NA	0	0	0
Post			2	NA						
Study			6	NA						
			10	NA						
Shallow	I	5	2	0	0	0	0	0	0	0
Air Injection			5	0	0	0	0	0	0	0
,			8	0	0	0	0	0	0	0
		1	23	0	0	0	0	0	0	0
	II	20	2	0	0	0	0	0	0	0
			5	00	0	0	0	0	0	0
			8	0	0	0	0	0	0	0
			23	0	0	0	0	0	0	0
Post		0	4	0	0	0	0	0	0	0
Study			88	00	0	0	0	0	0	0
			24	0	0	0	0	0	0	0

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Notes: NA - Not analyzed

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#### SOIL GAS PROBE PERCENT HELIUM BY VOLUME - PLUME B IAS TREATABILITY STUDY OPERABLE UNIT NO. 10 (SITE 35) CAMP LEJEUNE, NORTH CAROLINA

Test	Phase	Flow Rate (acfm)	Time (hours)	SG-1	SG-2	SG-3	SG-4	SG-5	SG-6
Pre-Study		0	0	0	0	0	0	0	0
Deep Air	I	7.5	3.5	2.90	0	0	0	0	0
Injection			18	1.70	0	0	0	0	0
	II	20	2.5	0.71	0	0.01	0	0	0
			5	1.00	0.01	0	0	0	0
			24	0.83	0.04	0	0	0	0
Shallow	I	5	2.5	0.04	0	0	0	0	0
Air Injection			8	0	0	0	0	0	0
njecton			23	0	0	0	0	0	0
	II	20	2	0	0	0	0	0	0
		-	5	0	0	0	0	0	0
			8	0	0	0	0	0	0
		1	23	0	0	0	0	0	0
Post		0	4	0	0	0	0	0	0
Study			8	0	0	0	0	0	0
			24	0	0	0	0	0	0

### PRE-TEST GROUNDWATER ANALYTICAL RESULTS - PLUME B IAS TREATABILITY STUDY OPERABLE UNIT NO. 10 (SITE 35) CAMP LEJEUNE, NORTH CAROLINA

Volatile Organic Compounds	35-GW-46A-01-00 (μg/L)	35-GW-46B-01-00 (μg/L)	35-GW-50A-01-00 (μg/L)	35-GW-50B-01-00 (μg/L)
Chlorobenzene	1.2 J	5.0 U	5.0 U	5.0 U
1,2-Dichloroethene (total)	120	88	11	37
Trichloroethene	24	8.5	2.0 J	2.4 J
Vinyl Chloride	1.4 J	1.2 J	10 U	10 U

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### DEEP AIR INJECTION, PHASE I, GROUNDWATER ANALYTICAL RESULTS - PLUME B IAS TREATABILITY STUDY OPERABLE UNIT NO. 10 (SITE 35) CAMP LEJEUNE, NORTH CAROLINA

Volatile Organic Compounds	35-GW-46A-02-20 (µg/L)	35-GW-46B-02-20 (μg/L)	35-GW-50A-02-20 (μg/L)	35-GW-50B-02-20 (μg/L)
Benzene	1.0 U	1.0 U	1.1	1.0 U
1,2-Dichloroethene (total)	130	86	10	36
Trichloroethene	22	8.5	2.1 J	2.1 J
Vinyl Chloride	10 U	1.1 J	10 U	10 U

### DEEP AIR INJECTION, PHASE II, GROUNDWATER ANALYTICAL RESULTS - PLUME B IAS TREATABILITY STUDY OPERABLE UNIT NO. 10 (SITE 35) CAMP LEJEUNE, NORTH CAROLINA

Volatile Organic Compounds	35-GW-46A-03-24 (μg/L)	35-GW-46B-03-24 (μg/L)	35-GW-50A-03-24 (μg/L)	35-GW-50B-03-24 (µg/L)
1,2-Dichloroethene (total)	99	77	9.9	41
Trichloroethene	13	7.4	1.9 J	2.6 J
Vinyl Chloride	10 U	1.0 J	10 U	10 U

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### SHALLOW AIR INJECTION, PHASE I, GROUNDWATER ANALYTICAL RESULTS PLUME B IAS TREATABILITY STUDY OPERABLE UNIT NO. 10 (SITE 35) CAMP LEJEUNE, NORTH CAROLINA

Volatile Organic Compounds	35-GW-46A-04-23 (µg/L)	35-GW-46B-04-23 (μg/L)	35-GW-50A-04-23 (μg/L)	35-GW-50B-04-23 (μg/L)		
1,2-Dichloroethene (total)	120	79	10	36 '		
Trichloroethene	21	7.3	1.8 J	1.7 J		
Vinyl Chloride	10 U	1.0 J	10 U	10 U		

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### SHALLOW AIR INJECTION, PHASE II, GROUNDWATER ANALYTICAL RESULTS PLUME B IAS TREATABILITY STUDY OPERABLE UNIT NO. 10 (SITE 35) CAMP LEJEUNE, NORTH CAROLINA

Volatile Organic Compounds	35-GW-46A-05-24 (μg/L)	35-GW-46B-05-24 (µg/L)	35-GW-50A-05-24 (µg/L)	35-GW-50B-05-24 (μg/L)
Benzene	1.0 U	1.0 U	1.3	1.0 U
Chlorobenzene	5.0 U	5.0 U	1.0 J	5.0 U
1,2-Dichloroethene (total)	130	80	9.7	32
Methylene Chloride	5.0 U	5.0 U	3.5 JB	3.7 JB
Trichloroethene	22	6.9	2.6 J	2.0 J

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#### POST TEST GROUNDWATER ANALYTICAL RESULTS - PLUME B IAS TREATABILITY STUDY OPERABLE UNIT NO. 10 (SITE 35) CAMP LEJEUNE, NORTH CAROLINA

Volatile Organic Compounds	35-GW-46A-06-24 (μg/L)	35-GW-46B-06-24 (μg/L)	35-GW-50A-06-24 (µg/L)	35-GW-50B-06-24 (μg/L)	
1,2-Dichloroethene (total)	130	70	9.9	28	
Trichloroethene	23	6.8	1.8 J	1.2 J	

### AIR SAMPLING ANALYTICAL RESULTS - PLUME B IAS TREATABILITY STUDY OPERABLE UNIT NO. 10 (SITE 35) CAMP LEJEUNE, NORTH CAROLINA

Sampling Location         SG-4         SG-5         SG-4         PTB         VAR         SG-4         SG-5         VAR         SG-4         SG-5         TRALER           Test         Pre-Study         Pre-Study         Pre-Study         Phase										,			
Test         Pre-Study         Pre-Study         Deep In, Phase I         Deep In, Phase I         Phase II         Phase I         Pha	SUMMA Canister ID #	1							I		0039		93148
Phase         Phase I         Aug I	Sampling Location	1	1						ł				ł
Date Collected         27-Jul         Jul 27         Aug 9         Aug 9         Aug 10         Aug 12         Aug 12         Aug 12         Aug 12         Aug 13         Aug 14         Aug 14         Aug 14           Time Collected         1400         945         945         905         900         900         900         800         650	Test	Pre-Study	Pre-Study	Deep Inj.					1 -		Post-Study	Post-Study	Post-Study
Time Collected         1400         945         945         905         745         900         900         800         650	Phase					1				1			
Units         PPB(V/V)         PPB(V/V) <t< td=""><td></td><td></td><td></td><td>-</td><td>-</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<>				-	-								
M-Xylene & P-Xylene         6.4         2.2         0.57         0.44         0.43 U         0.73         0.42 U         0.41 U         0.42 U         0.41 U           Ethylbenzene         2.1         0.57         0.43 U         0.42 U         0.43 U         0.42 U         0.42 U         0.41 U         0.42 U         0.41 U <td></td> <td></td> <td></td> <td></td> <td></td> <td>1</td> <td></td> <td>4</td> <td></td> <td></td> <td>1</td> <td></td> <td>1</td>						1		4			1		1
Ethylbenzene         2.1         0.57         0.43 U         0.42 U         0.43 U         0.42 U         0.41 U         0.42 U <th0.41 th="" u<="">           N-Decane<td></td><td>PPB(V/V)</td><td>1</td><td></td><td></td><td>1</td><td></td><td></td><td>·····</td><td></td><td></td><td></td><td>r i i i i i i i i i i i i i i i i i i i</td></th0.41>		PPB(V/V)	1			1			·····				r i i i i i i i i i i i i i i i i i i i
Styrene         1.5         0.67         0.43 U         0.42 U         0.43 U         0.42 U         0.42 U         0.41 U         0.42 U         0.42 U         0.41 U         0.42 U         0.42 U         0.92         0.42 U         0.41 U         1         0.61         0.42 U         0.41 U         0.42 U         0.42 U         0.41 U         0.42 U         0.42 U         0.41 U         0.42 U <th0.41 th="" u<=""> <th0.42 th="" u<=""> <th0.41 td="" u<<=""><td>M-Xylene &amp; P-Xylene</td><td>6.4</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></th0.41></th0.42></th0.41>	M-Xylene & P-Xylene	6.4											
N-Butane         4.5         1.9         1.3         0.42 U         0.61         1.6         0.65         0.42 U         0.53         0.92         0.42 U         0.92           Toluene         26         9.4         2.1         1.6         0.43 U         1.3         1.2         0.82         0.41 U         1         0.61         0.49           Pentane         4.7         1.2         0.91         0.42 U         0.43 U         0.42 U         0.42 U         0.41 U         0.5         0.42 U         0.41 U         0.42 U         0.42 U         0.41	Ethylbenzene	2.1	0.57	0.43 U	0.42 U	0.43 U	0.43 U	0.42 U	0.42 U	0.41 U	0.42 U	0.42 U	0.41 U
Toluene269.42.11.6 $0.43 U$ 1.31.2 $0.82$ $0.41 U$ 1 $0.61$ $0.49$ Pentane4.71.2 $0.91$ $0.42 U$ $0.46$ $1.3$ $0.45$ $0.42 U$ $0.41 U$ $0.5$ $0.42 U$ $0.41 U$ N-Hexane1.7 $0.42 U$ $0.43 U$ $0.42 U$ $0.43 U$ $0.42 U$ $0.42 U$ $0.41 U$ $0.42 U$ $0.41 U$ N-Octane1 $0.42 U$ $0.43 U$ $0.43 U$ $0.42 U$ $0.42 U$ $0.41 U$ $0.42 U$ $0.41 U$ N-Undecane3.41.4 $0.6$ $1.4$ $0.43 U$ $0.43 U$ $0.42 U$ $0.41 U$ $0.42 U$ $0.42 U$ $0.41 U$ N-Dodecane1.1 $0.79$ $0.43 U$ $0.42 U$ $0.43 U$ $0.42 U$ $0.41 U$ $0.42 U$ $0.42 U$ $0.41 U$ N-Dodecane1.6 $0.42 U$ $0.43 U$ $0.43 U$ $0.43 U$ $0.42 U$ $0.41 U$ $0.42 U$ $0.42 U$ N-Decane7.5 $0.42 U$ $1.1$ $1.2$ $0.43 U$ $0.43 U$ $0.42 U$ $0.41 U$ $0.42 U$ $0.41 U$ N-Decane7.5 $0.42 U$ $1.1$ $1.2$ $0.43 U$ $0.43 U$ $0.42 U$ $0.41 U$ $0.42 U$ $0.41 U$ N-Decane7.5 $0.42 U$ $1.1$ $1.2$ $0.43 U$ $0.43 U$ $0.42 U$ $0.41 U$ $0.42 U$ $0.41 U$ N-Heptane $0.71$ $0.42 U$ $0.43 U$ $0.43 U$ $0.42 U$ $0.42 U$ $0.41 U$ $0.42 U$	Styrene	1.5	0.67	0.43 U	0.42 U	0.43 U	0.43 U	0.42 U	0.42 U	0.41 U	0.42 U	0.42 U	0.41 U
Pentane         4.7         1.2         0.91         0.42 U         0.46         1.3         0.45         0.42 U         0.41 U         0.5         0.42 U         0.41 U           N-Hexane         1.7         0.42 U         0.43 U         0.43 U         0.43 U         0.42 U         0.43 U         0.42 U         0.42 U         0.41 U         0.42 U         0.42 U         0.41 U         0.42 U         0.42 U         0.43 U         0.42 U         0.41 U         0.42 U	N-Butane	4.5	1.9	1.3	0.42 U	0.61	1.6	0.65	0.42 U	0.53	0.92	0.42 U	0.92
N-Hexane         1.7         0.42 U         0.43 U         0.43 U         0.42 U         0.42 U         0.41 U         0.42 U         0.42 U         0.41 U           N-Octane         1         0.42 U         0.43 U         0.43 U         0.43 U         0.42 U         0.41 U         0.42 U	Toluene	26	9.4	2.1	1.6	0.43 U	1.3	1.2	0.82	0.41 U	1	0.61	0.49
N-Octane         1         0.42 U         0.43 U         0.43 U         0.42 U         0.42 U         0.41 U <th0.41 th="" u<=""></th0.41>	Pentane	4.7	1.2	0.91	0.42 U	0.46	1.3	0.45	0.42 U	0.41 U	0.5	0.42 U	0.44
N-Undecane         3.4         1.4         0.6         1.4         0.43 U         0.43 U         0.5         0.42 U         0.41 U         0.43 U         0.41 U           N-Dodecane         1.1         0.79         0.43 U         0.42 U         0.43 U         0.42 U         0.42 U         0.41 U         0.42 U	N-Hexane	1.7	0.42 U	0.43 U	0.42 U	0.43 U	0.43 U	0.42 U	0.42 U	0.41 U	0.42 U	0.42 U	0.41 U
N-Dodecane         1.1         0.79         0.43 U         0.42 U         0.43 U         0.42 U         0.41 U         0.42 U         0.42 U         0.41 U         0.42 U </td <td>N-Octane</td> <td>1</td> <td>0.42 U</td> <td>0.43 U</td> <td>0.4<b>2</b> U</td> <td>0.43 U</td> <td>0.43 U</td> <td>0.42 U</td> <td>0.42 U</td> <td>0.41 U</td> <td>0.42 U</td> <td>0.42 U</td> <td>0.41 U</td>	N-Octane	1	0.42 U	0.43 U	0.4 <b>2</b> U	0.43 U	0.43 U	0.42 U	0.42 U	0.41 U	0.42 U	0.42 U	0.41 U
Nonane1.60.42 U0.43 U0.42 U0.43 U0.43 U0.42 U0.42 U0.41 U0.42 U0.42 U0.41 UN-Decane7.50.42 U1.11.20.43 U0.43 U0.43 U1.60.880.41 U0.950.740.41 UTetrachloroethene0.44 U0.42 U0.43 U0.42 U1.10.43 U0.43 U0.42 U0.41 U0.42 U0.41 UN-Heptane0.710.42 U0.43 U0.42 U1.10.43 U0.42 U0.42 U0.41 U0.42 U0.41 UN-Heptane2.30.42 U0.43 U0.42 U1.40.80.42 U0.42 U0.41 U0.42 U0.41 UChloroffrm0.44 U1.40.43 U0.960.43 U0.43 U0.42 U0.42 U0.41 U0.42 U0.41 UChloromethane0.610.42 U0.43 U0.43 U0.43 U0.42 U0.42 U0.41 U0.42 U0.41 UChloromethane0.610.42 U0.43 U0.43 U0.43 U0.42 U0.41 U0.42 U0.41 UChloromethane0.610.42 U0.730.42 U0.43 U0.43 U0.42 U0.41 U0.42 U0.41 UDichlorodifluoromethane0.680.70.740.63 U0.651.10.42 U0.62 U0.62 U0.63 U0.61 UDichlorodifluoromethane0.680.70.740.80.610.64 U0.62 U0.41 U0.42 U0.	N-Undecane	3.4	1.4	0.6	1.4	0.43 U	0.43 U	0.5	0.42 U	0.41 U	0.43	0.42 U	0.41 U
N-Decane         7.5         0.42 U         1.1         1.2         0.43 U         0.43 U         1.6         0.88         0.41 U         0.95         0.74         0.41 U           Tetrachloroethene         0.44 U         0.42 U         0.43 U         0.42 U         1.1         0.43 U         0.49         0.42 U         0.41 U         U <t< td=""><td>N-Dodecane</td><td>1.1</td><td>0.79</td><td>0.43 U</td><td>0.42 U</td><td>0.43 U</td><td>0.43 U</td><td>0.42 U</td><td>0.42 U</td><td>0.41 U</td><td>0.42 U</td><td>0.42 U</td><td>0.41 U</td></t<>	N-Dodecane	1.1	0.79	0.43 U	0.42 U	0.43 U	0.43 U	0.42 U	0.42 U	0.41 U	0.42 U	0.42 U	0.41 U
Tetrachloroethene0.44 U0.42 U0.43 U0.42 U1.10.43 U0.490.42 U0.41 U0.42 U0.42 U0.41 UN-Heptane0.710.42 U0.43 U0.42 U0.43 U0.43 U0.42 U0.42 U0.41 U0.42 U0.41 U0.42 U0.41 Uvisi-1,2-Dichloroethene2.30.42 U0.43 U0.42 U1.40.80.42 U0.42 U0.41 U0.42 U0.42 U0.41 UChloroform0.44 U1.40.43 U0.960.43 U0.43 U0.42 U0.740.41 U0.42 U0.42 U0.41 UBenzene141.41.3350.43 U0.7721420.41 U19400.41 UChlorofirm0.610.42 U0.730.42 U0.630.651.10.42 U0.8410.42 U0.59Carbon Disulfide1.40.64 U0.64 U0.63 U0.64 U11.40.64 U0.62 U0.62 U0.62 U0.63 U0.61Dichlorodifluoromethane0.680.70.740.80.610.640.650.640.590.660.680.64O-Xylene1.90.740.43 U0.42 U0.43 U0.43 U0.43 U0.43 U0.42 U0.41 U0.42 U0.41 U1,2,4-Trimethylbenzene1.10.570.43 U0.42 U0.43 U0.43 U0.42 U0.41 U0.42 U0.41 UCurnene51.8	Nonane	1.6	0.42 U	0.43 U	0.4 <b>2</b> U	0.43 U	0.43 U	0.42 U	0.42 U	0.41 U	0.42 U	0.42 U	0.41 U
N-Heptane         0.71         0.42 U         0.43 U         0.42 U         0.43 U         0.42 U         0.42 U         0.41 U         0.42 U         0.42 U         0.41 U           cis-1,2-Dichloroethene         2.3         0.42 U         0.43 U         0.42 U         1.4         0.8         0.42 U         0.41 U         0.42 U         0.42 U         0.41 U         0.42 U         0.42 U         0.41	N-Decane	7.5	0.42 U	1.1	1.2	0.43 U	0.43 U	1.6	0.88	0.41 U	0.95	0.74	0.41 U
cis-1,2-Dichloroethene2.30.42 U0.43 U0.42 U1.40.80.42 U0.42 U0.750.42 U0.42 U0.41 UChloroform0.44 U1.40.43 U0.960.43 U0.43 U0.42 U0.740.41 U0.42 U0.990.41 UBenzene141.413350.43 U0.7721420.41 U19400.41 UChloromethane0.610.42 U0.730.42 U0.630.651.10.42 U0.8410.42 U0.59Carbon Disulfide1.40.64 U0.64 U0.63 U0.64 U11.40.64 U0.62 U0.62 U0.62 U0.63 U0.61 UDichlorodifluoromethane0.680.70.740.80.610.640.650.640.590.660.680.64O-Xylene1.90.740.43 U0.42 U0.43 U0.43 U0.43 U0.42 U0.41 U0.42 U0.42 U0.41 U1,2,4-Trimethylbenzene1.10.570.43 U0.42 U0.43 U0.43 U0.42 U0.41 U0.42 U0.42 U0.41 UCurnene51.80.720.580.43 U0.43 U0.570.42 U0.41 U0.42 U0.41 U	Tetrachloroethene	0.44 U	0.42 U	0.43 U	0.42 U	1.1	0.43 U	0.49	0.42 U	0.41 U	0.42 U	0.42 U	0.41 U
Chloroform0.44 U1.40.43 U0.960.43 U0.43 U0.42 U0.740.41 U0.42 U0.92 U0.41 UBenzene141.413350.43 U0.7721420.41 U19400.41 UChloromethane0.610.42 U0.730.42 U0.630.651.10.42 U0.8410.42 U0.59Carbon Disulfide1.40.64 U0.64 U0.63 U0.64 U11.40.64 U0.62 U0.62 U0.62 U0.63 U0.61 UDichlorodifluoromethane0.680.70.740.80.610.640.650.640.590.660.680.64O-Xylene1.90.740.43 U0.42 U0.43 U0.43 U0.42 U0.42 U0.41 U0.42 U0.42 U0.41 U1,2,4-Trimethylbenzene1.10.570.43 U0.42 U0.43 U0.43 U0.42 U0.41 U0.42 U0.42 U0.41 UCurnene51.80.720.580.43 U0.43 U0.570.42 U0.41 U0.42 U0.41 U	N-Heptane	0.71	0.42 U	0.43 U	0.42 U	0.43 U	0.43 U	0.42 U	0.42 U	0.41 U	0.42 U	0.42 U	0.41 U
Benzene141.413350.43 U0.7721420.41 U19400.41 UChloromethane0.610.42 U0.730.42 U0.630.651.10.42 U0.8410.42 U0.59Carbon Disulfide1.40.64 U0.64 U0.63 U0.64 U11.40.64 U0.62 U0.62 U0.62 U0.63 U0.61 UDichlorodifluoromethane0.680.70.740.80.610.640.650.640.590.660.680.64O-Xylene1.90.740.43 U0.42 U0.43 U0.42 U0.43 U0.42 U0.42 U0.41 U0.42 U0.41 U1,2,4-Trimethylbenzene1.10.570.43 U0.42 U0.43 U0.43 U0.42 U0.42 U0.41 U0.42 U0.41 UCurnene51.80.720.580.43 U0.43 U0.570.42 U0.41 U0.42 U0.41 U	cis-1,2-Dichloroethene	2.3	0.42 U	0.43 U	0.42 U	1.4	0.8	0.42 U	0.42 U	0.75	0.42 U	0.42 U	0.41 U
Chloromethane0.610.42 U0.730.42 U0.630.651.10.42 U0.8410.42 U0.59Carbon Disulfide1.40.64 U0.64 U0.63 U0.64 U11.40.64 U0.62 U0.62 U0.63 U0.61 UDichlorodifluoromethane0.680.70.740.80.610.640.650.640.590.660.680.64O-Xylene1.90.740.43 U0.42 U0.43 U0.42 U0.43 U0.42 U0.42 U0.41 U0.42 U0.41 U1,2,4-Trimethylbenzene1.10.570.43 U0.42 U0.43 U0.43 U0.42 U0.41 U0.42 U0.41 UCurnene51.80.720.580.43 U0.43 U0.570.42 U0.41 U0.480.42 U0.41 U	Chloroform	0.44 U	1.4	0.43 U	0.96	0.43 U	0.43 U	0.42 U	0.74	0.41 U	0.42 U	0.9	0.41 U
Carbon Disulfide1.40.64 U0.64 U0.63 U0.64 U11.40.64 U0.62 U0.62 U0.63 U0.61 UDichlorodifluoromethane0.680.70.740.80.610.640.650.640.590.660.680.64O-Xylene1.90.740.43 U0.42 U0.43 U0.43 U0.42 U0.42 U0.41 U0.42 U0.42 U0.41 U1,2,4-Trimethylbenzene1.10.570.43 U0.42 U0.43 U0.43 U0.42 U0.42 U0.41 U0.42 U0.42 U0.41 UCurnene51.80.720.580.43 U0.43 U0.570.42 U0.41 U0.480.42 U0.41 U	Benzene	14	1.4	13	35	0.43 U	0.77	21	42	0.41 U	19	40	0.41 U
Dichlorodifluoromethane         0.68         0.7         0.74         0.8         0.61         0.64         0.65         0.64         0.59         0.66         0.68         0.64           O-Xylene         1.9         0.74         0.43 U         0.42 U         0.43 U         0.42 U         0.42 U         0.42 U         0.42 U         0.42 U         0.41 U         0.41 U         0.42 U         0.41 U	Chloromethane	0.61	0.42 U	0.73	0.42 U	0.63	0.65	1.1	0.42 U	0.84	1	0.42 U	0.59
D-Xylene       1.9       0.74       0.43 U       0.42 U       0.43 U       0.43 U       0.42 U       0.42 U       0.41 U       0.42 U       0.42 U       0.41 U         1,2,4-Trimethylbenzene       1.1       0.57       0.43 U       0.42 U       0.43 U       0.43 U       0.42 U       0.42 U       0.41 U       0.42 U       0.42 U       0.41 U         1,2,4-Trimethylbenzene       1.1       0.57       0.43 U       0.43 U       0.43 U       0.42 U       0.41 U       0.42 U       0.42 U       0.41 U         Cumene       5       1.8       0.72       0.58       0.43 U       0.43 U       0.57       0.42 U       0.41 U       0.48       0.42 U       0.41 U	Carbon Disulfide	1.4	0.64 U	0.64 U	0.6 <b>3</b> U	0.64 U	1	1.4	0.64 U	0.62 U	0.62 U	0.63 U	0.61 U
1,2,4-Trimethylbenzene1.10.570.43 U0.42 U0.43 U0.43 U0.42 U0.42 U0.41 U0.42 U0.42 U0.41 UCumene51.80.720.580.43 U0.43 U0.570.42 U0.41 U0.480.42 U0.41 U	Dichlorodifluoromethane	0.68	0.7	0.74	0.8	0.61	0.64	0.65	0.64	0.59	0.66	0.68	0.64
Sumene         5         1.8         0.72         0.58         0.43 U         0.43 U         0.57         0.42 U         0.41 U         0.48         0.42 U         0.41 U	O-Xylene	1.9	0.74	0.43 U	0.42 U	0.43 U	0.43 U	0.42 U	0.42 U	0.41 U	0.42 U	0.42 U	0.41 U
	1,2,4-Trimethylbenzene	1.1	0.57	0.43 U	0.4 <b>2</b> U	0.43 U	0.43 U	0.42 U	0.42 U	0.41 U	0.42 U	0.42 U	0.41 U
	Cumene	5		+	0.58	0.43 U	0.43 U	÷	0.42 U	0.41 U			
	Alpha-Methylstyrene	1.5	0.42 U	0.43 U	0.4 <b>2</b> U	0.43 U	0.43 U	0.42 U	0.42 U	0.41 U	0.42 U	0.42 U	0.41 U
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### COMPARISON OF POSITIVE DETECTIONS TO AMBIENT AIR RBCs IAS TREATABILITY STUDY OPERABLE UNIT NO. 10 (SITE 35) CAMP LEJEUNE, NORTH CAROLINA

Contaminant	Minimum Value (PPB)	Maximum Value (PPB)	SUMMA Canister ID# of Maximum Detected Value	Location of Maximum Detected Value	Frequency of Detection	Region III Ambient Air RBC <sup>(1)</sup> (PPB)	No. of RBC Exceedences
M-Xylene & P-Xylene	0.73	0.73	92003	44A	1/4	7,300	0
N-Butane	0.53	1.6	92003	44A	4/4	NE	NA
Toluene	0.49	1.3	92003	44A	2/4	420	0
Pentane	0.44	1.3	92003	44A	3/4	NE	NA
Tetrachloroethene	1.1	1.1	04330	47B	1/4	3.1	0
cis-1,2-Dichloroethene	0.75	1.4	04330	47B	3/4	37	0
Benzene	0.77	0.77	92003	44A	1/4	0.22	1
Chloromethane	0.59	0.84	12544	44A	4/4	0.99	0
Carbon Disulfide	1	1	92003	44A	1/4	730	0
Dichlorodifluoromethane	0.59	0.64	92003, 93148	44A, Trailer	4/4	210	0

Notes:

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<sup>(1)</sup> USEPA Region III Risk-Based Concentration Table. January-June, 1996.

NE - Not established

NA - Not applicable

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#### SUPPLEMENTAL POST-TEST GROUNDWATER ANALYTICAL RESULTS - PLUME B IAS TREATABILITY STUDY OPERABLE UNIT NO. 10 (SITE 35) CAMP LEJEUNE, NORTH CAROLINA

Volatile Organic Compounds	35-GW-46A-07 µg/L	35-GW-46B-07 µg/L	35-GW-50A-07 μg/L	35-GW-50B-07 μg/L
1,2-Dichloroethene (total)	160	75	12	31
Trichloroethene	25	10 U	10 U	10 U

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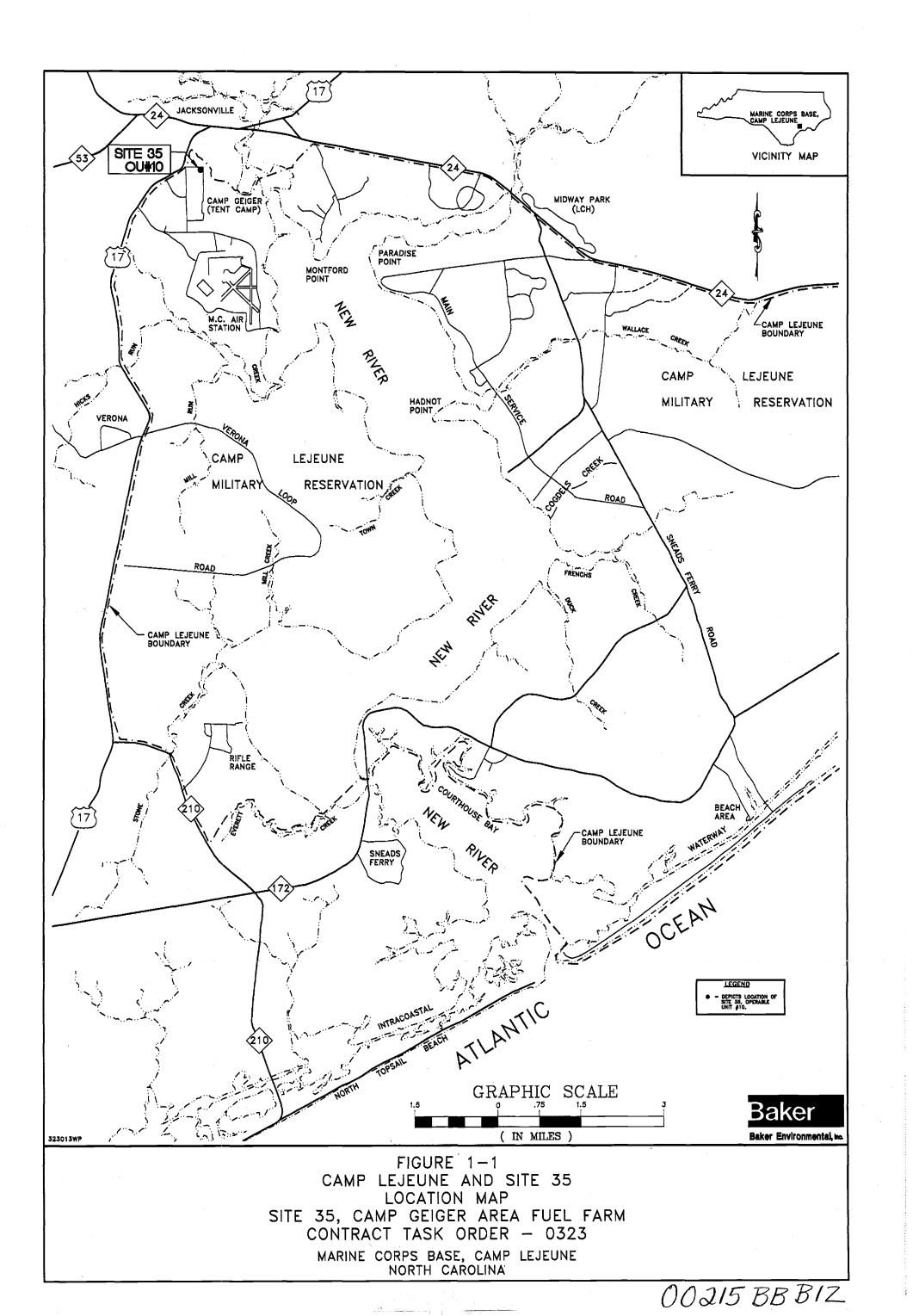
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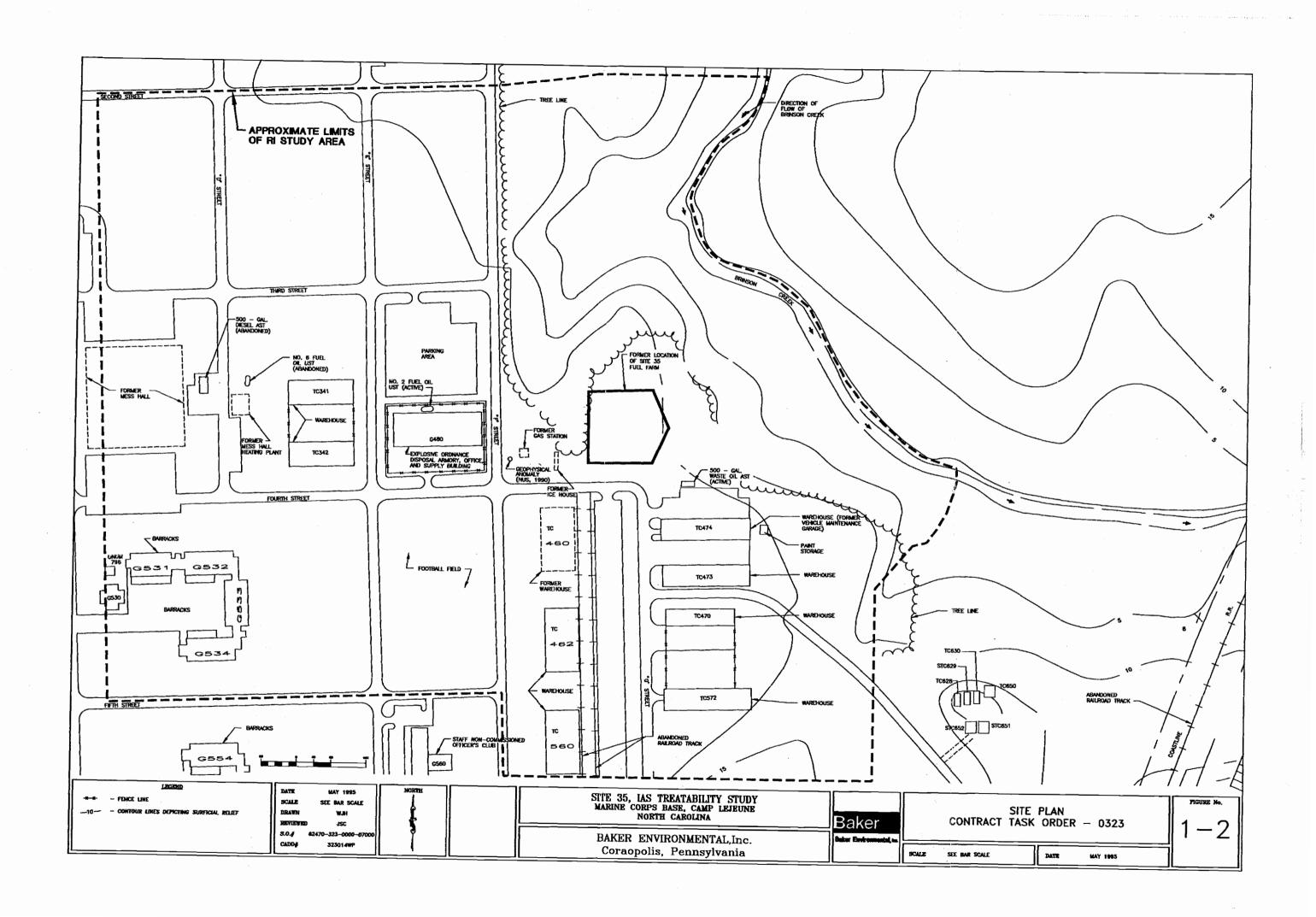
### SUPPLEMENTAL POST-TEST GROUNDWATER ANALYTICAL RESULTS - PLUME C IAS TREATABILITY STUDY OPERABLE UNIT NO. 10 (SITE 35) CAMP LEJEUNE, NORTH CAROLINA

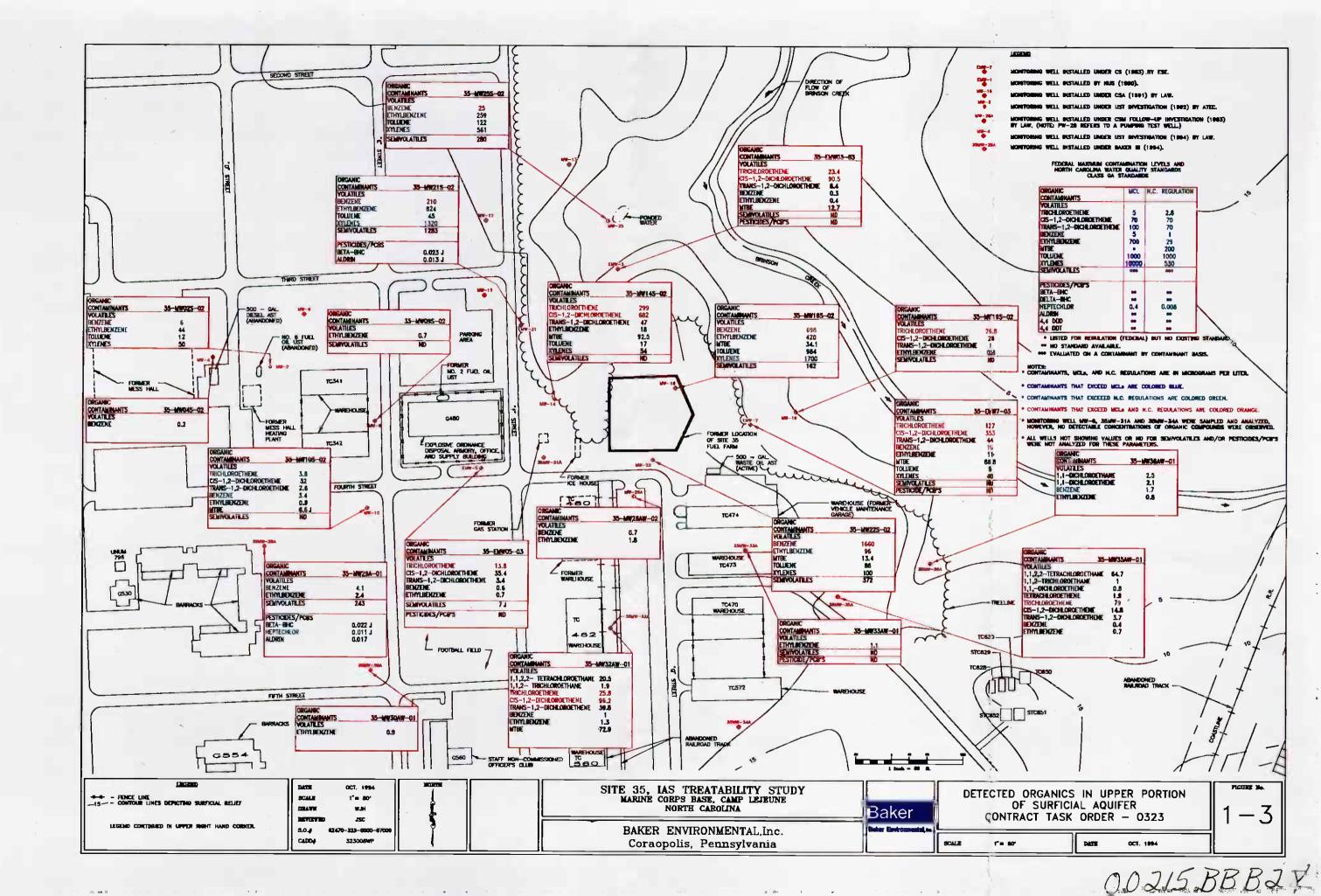
Volatile Organic Compounds	35-GW-53A-07 µg/L	35-GW-55A-07 μg/L	35-GW-56B-07 µg/L	35-GW-57B-07 μg/L
1,2-Dichloroethene (total)	270	410	1400	1200
1,1,2,2-Tetrachloroethane	10 U	10 U	10 U	35
Trichloroethene	63	180	870	780
Vinyl Chloride	10 U	10 U	44	23

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FIGURES

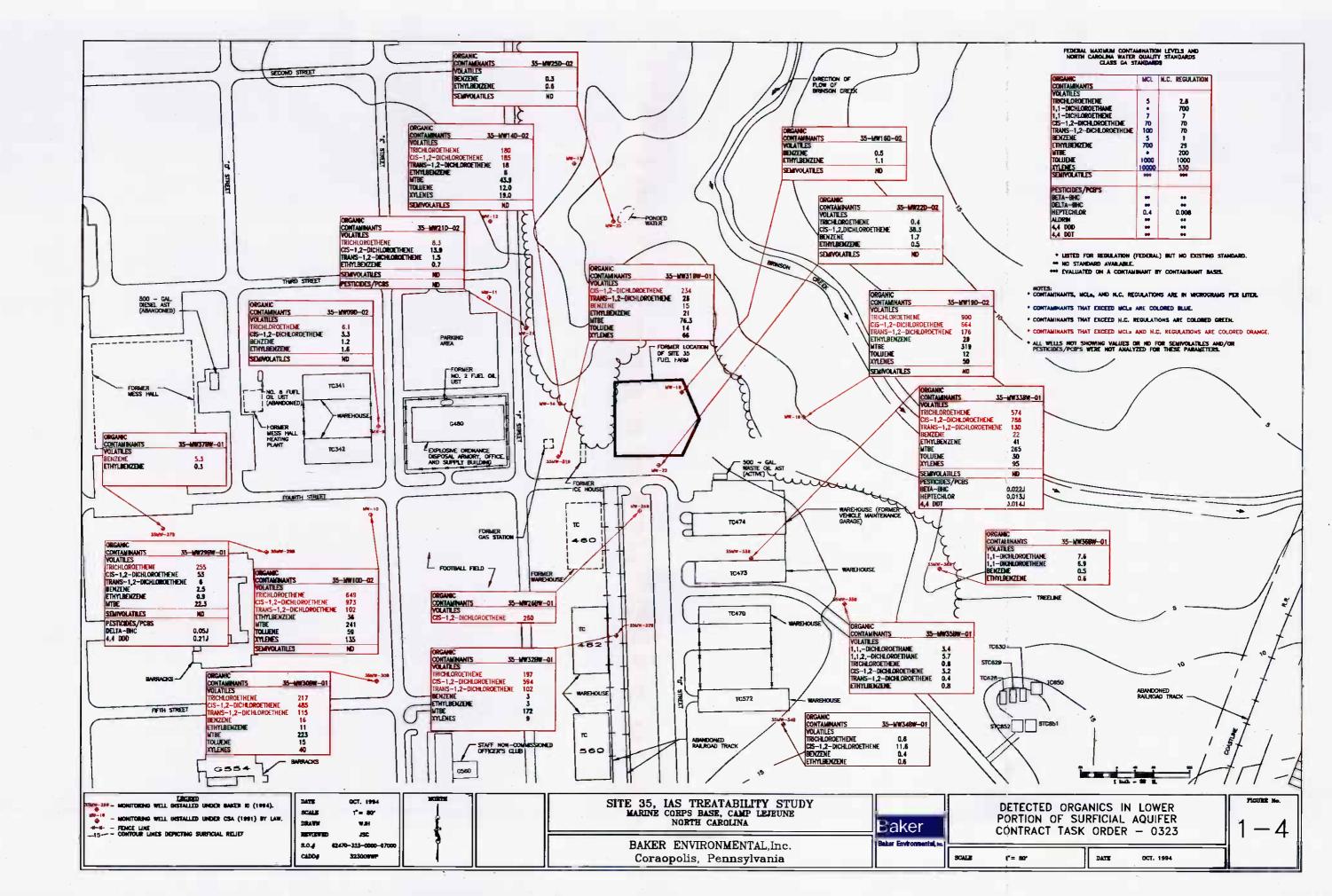


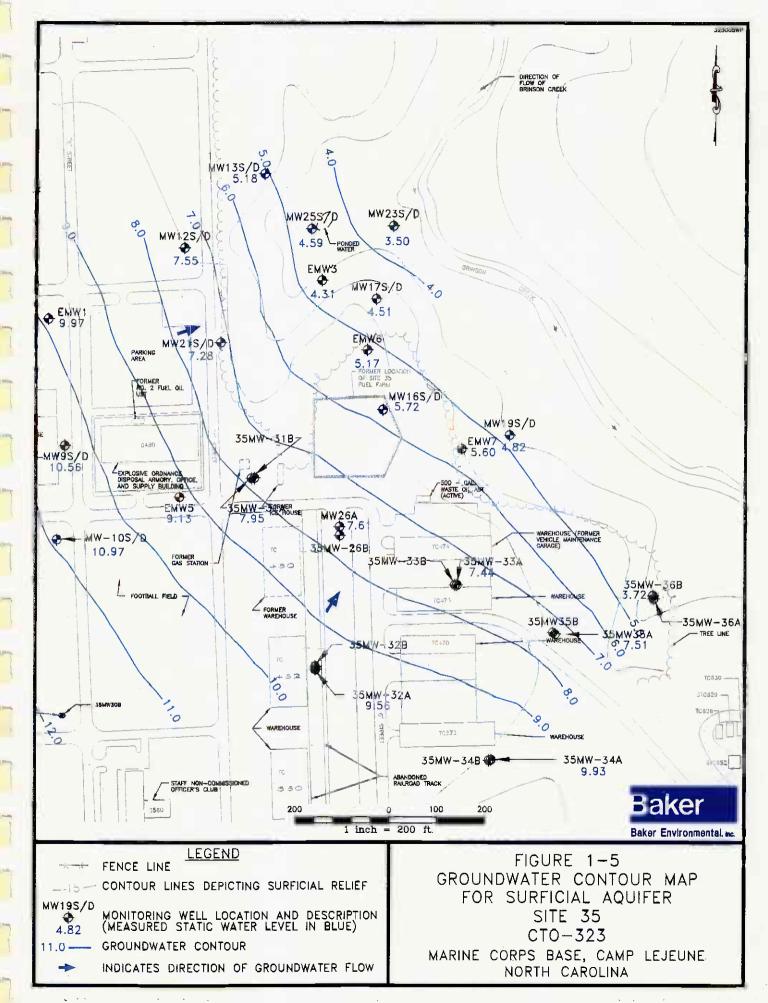


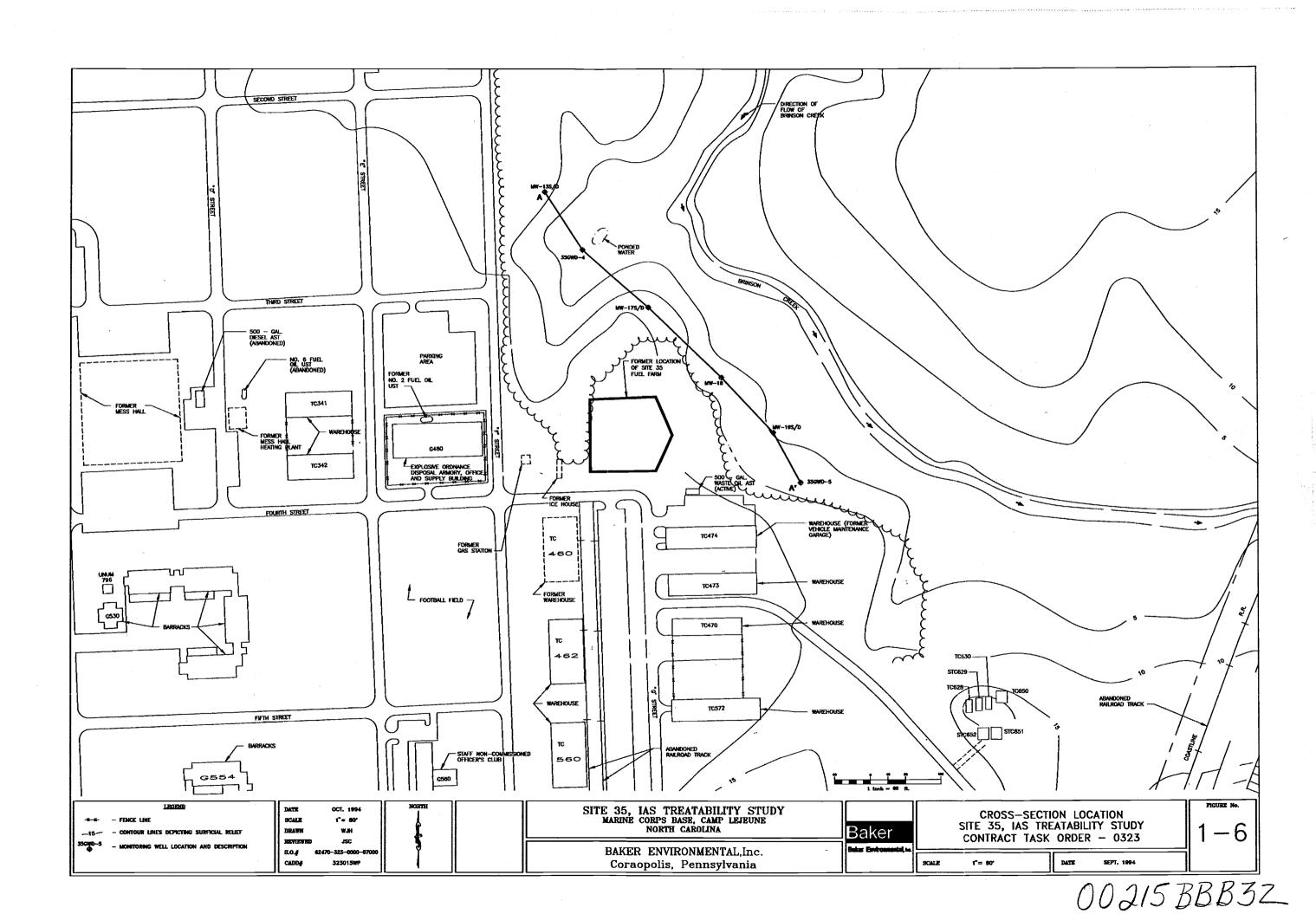


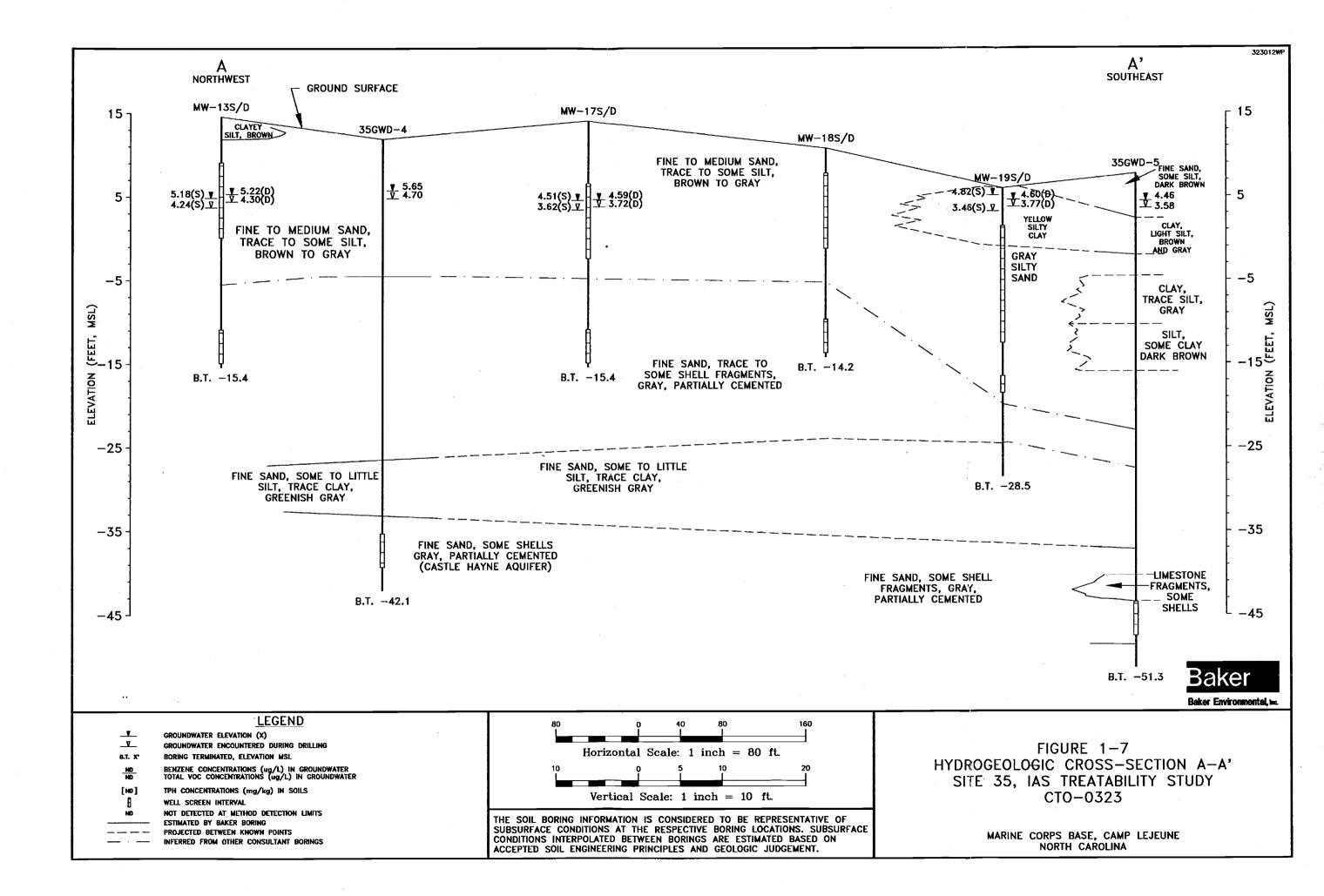
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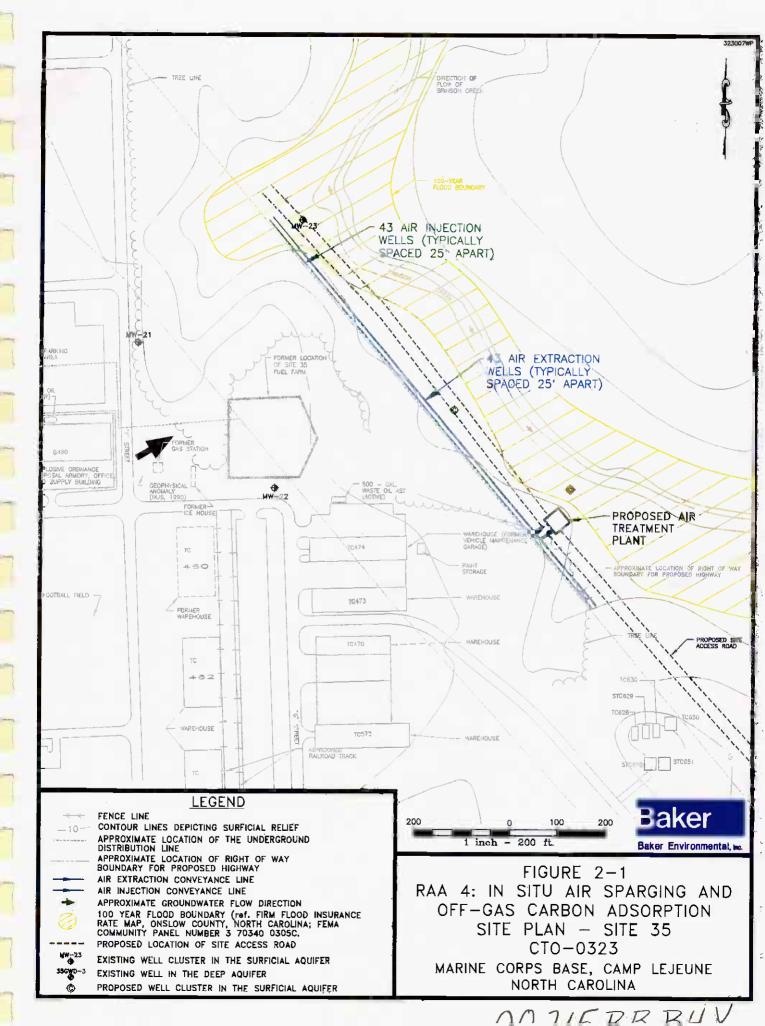
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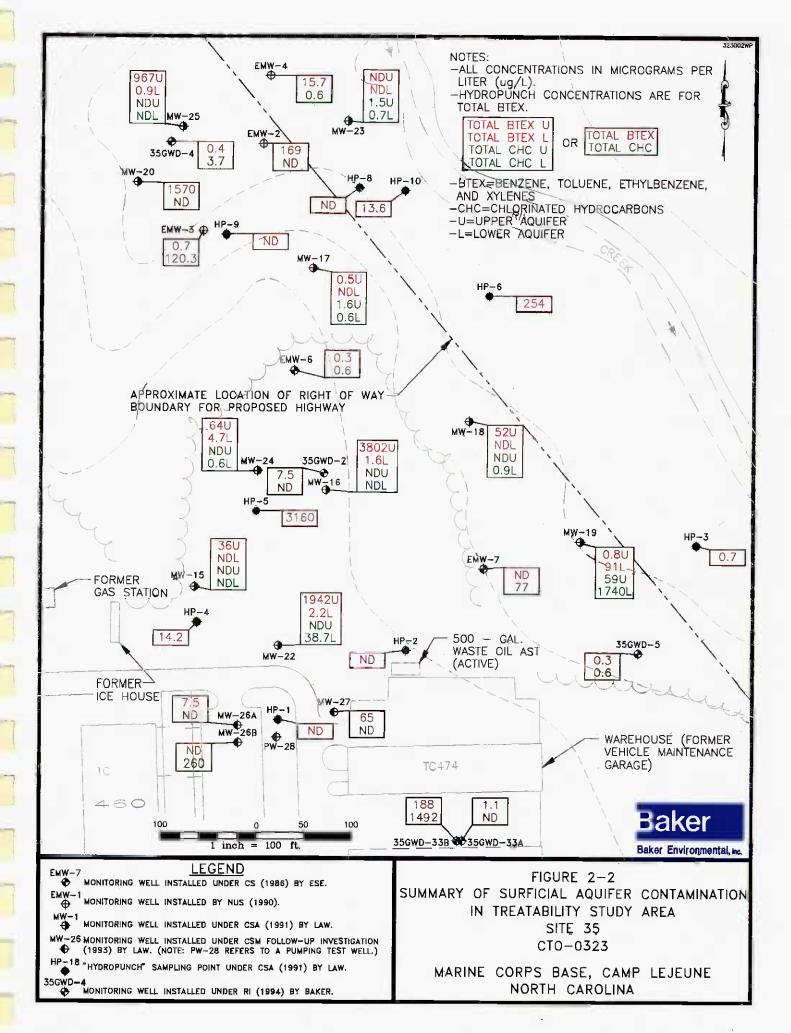


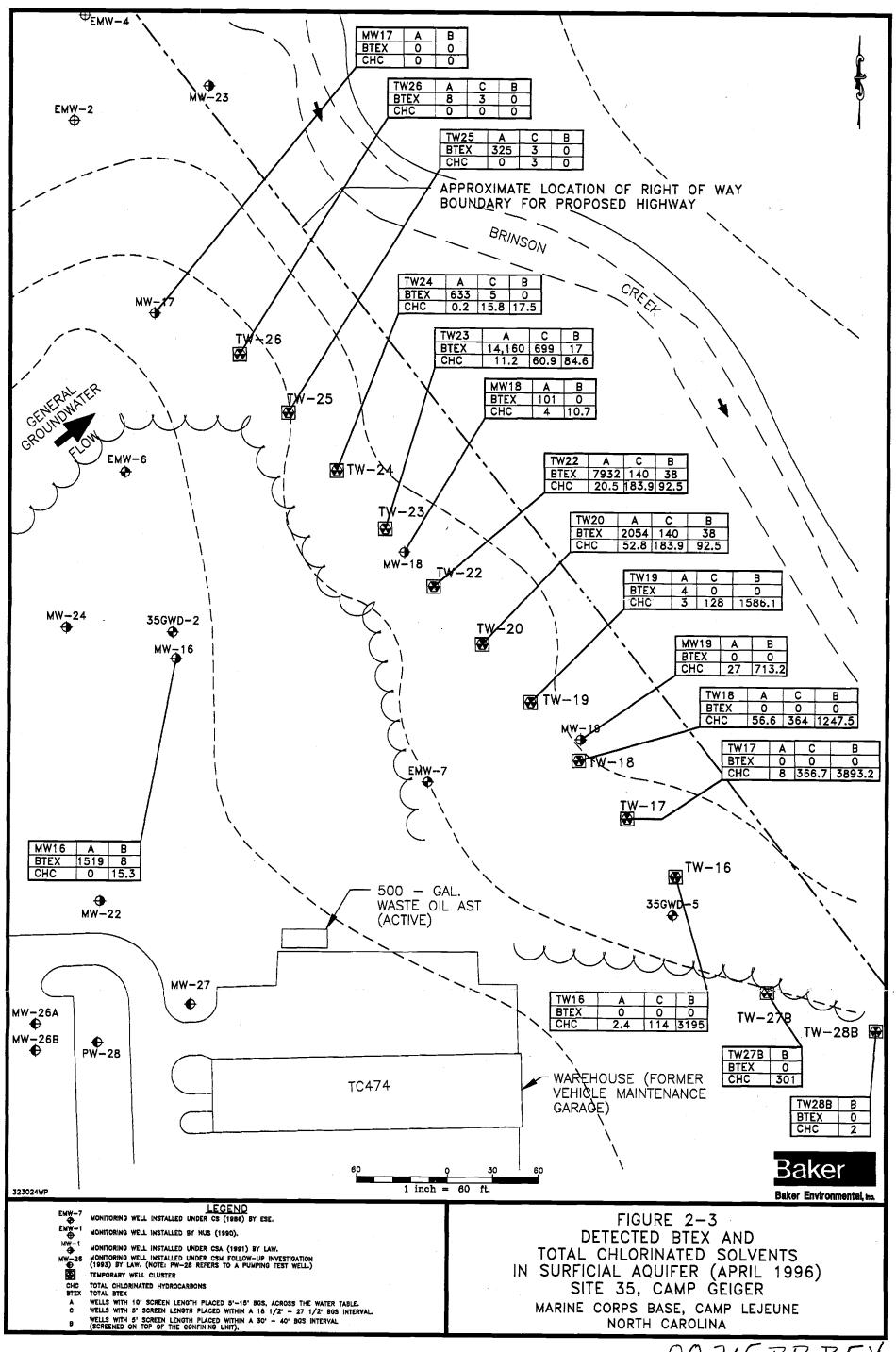




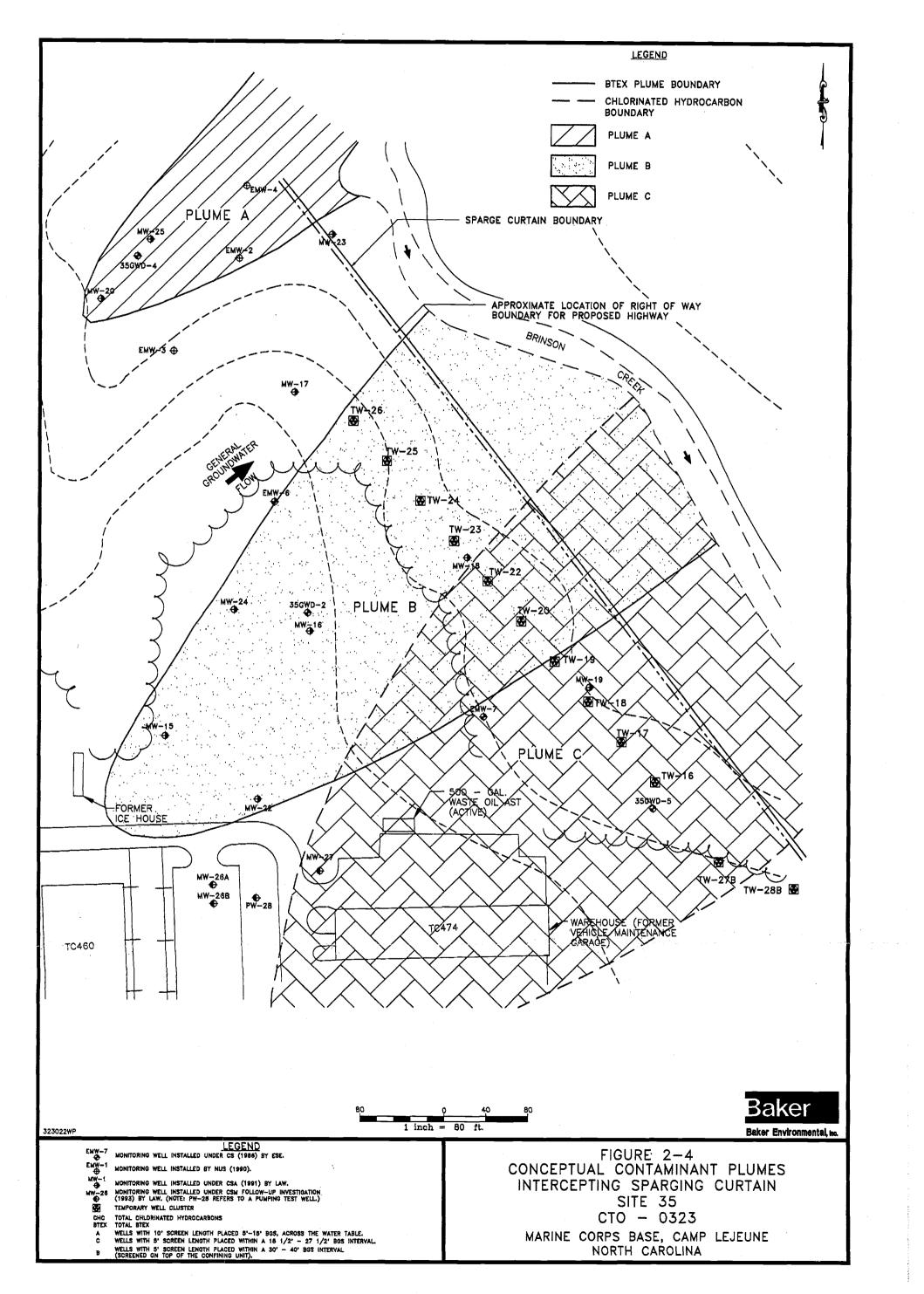


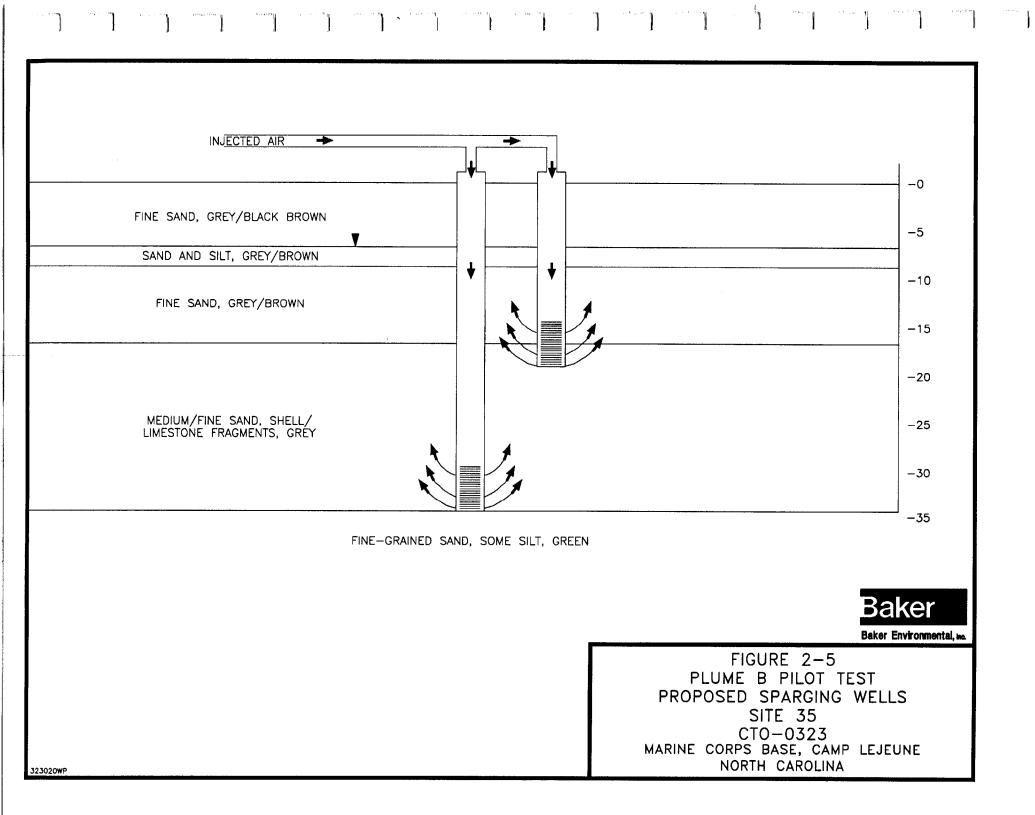


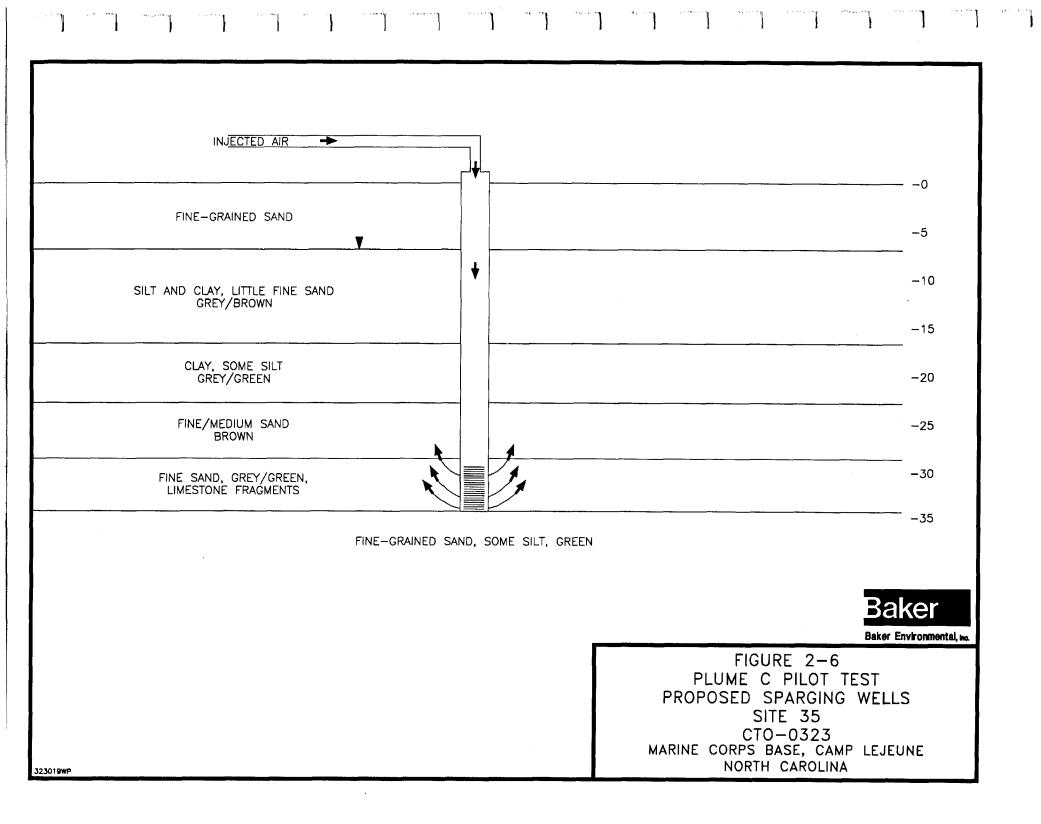


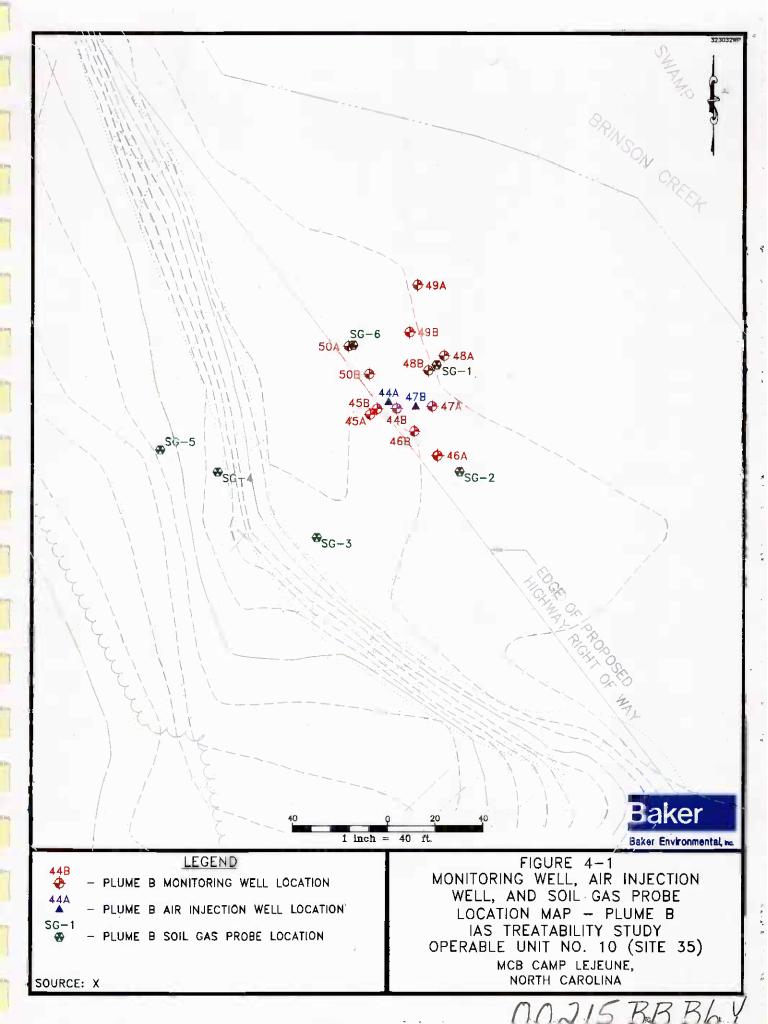


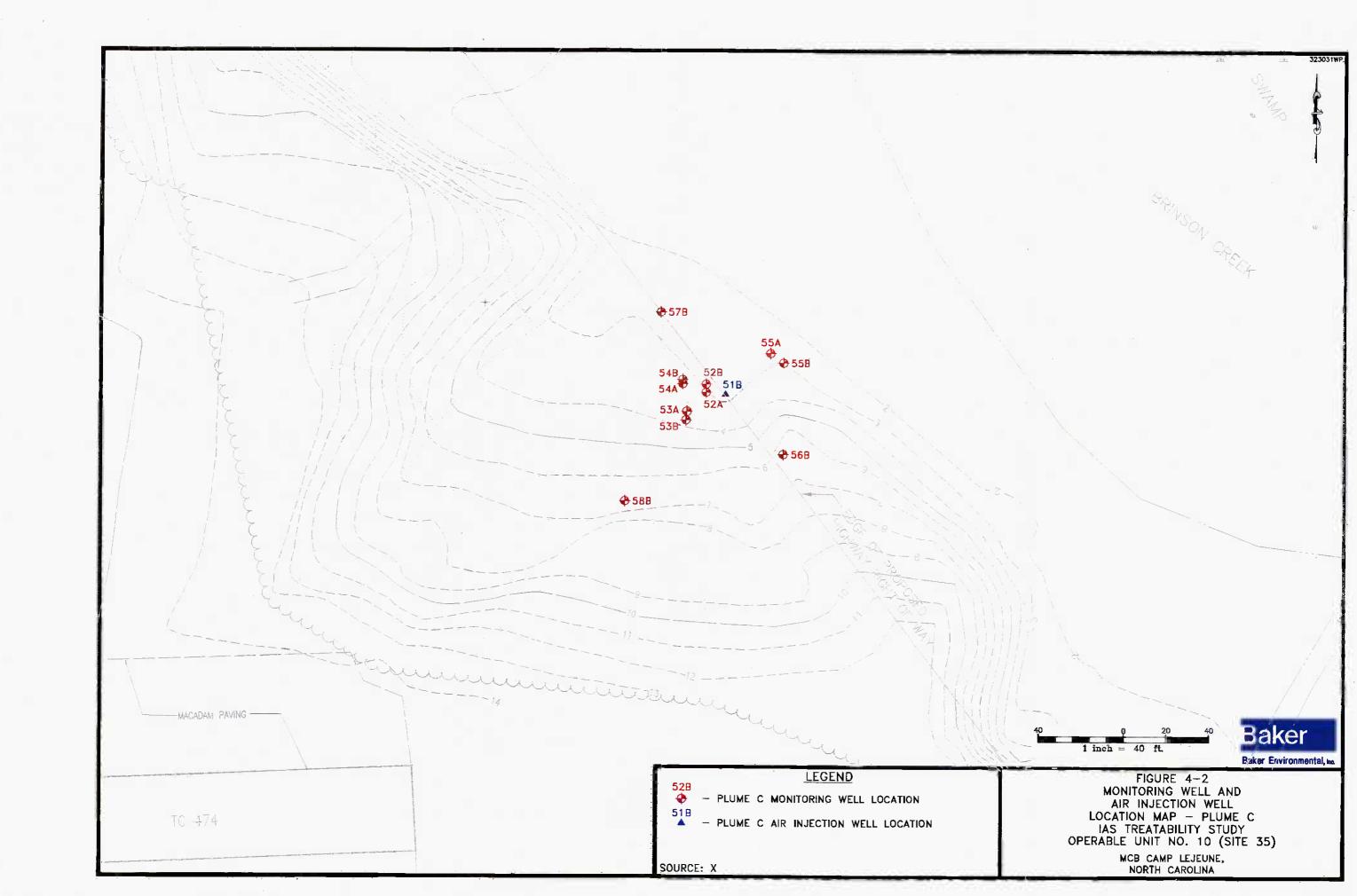
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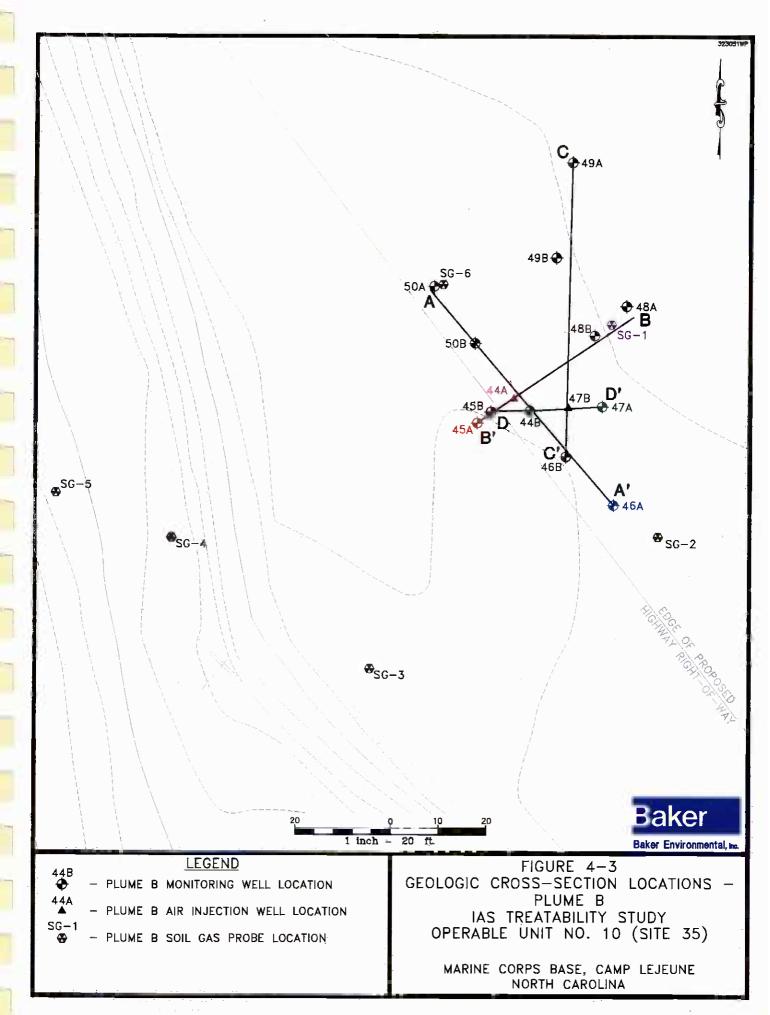




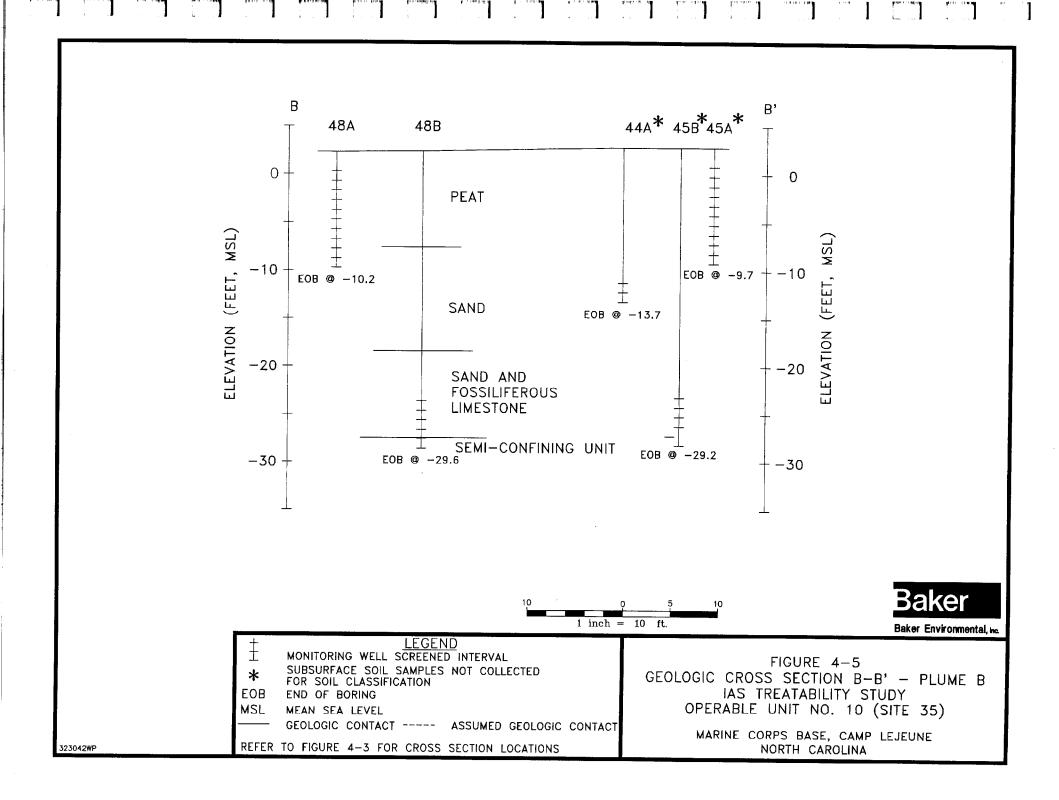




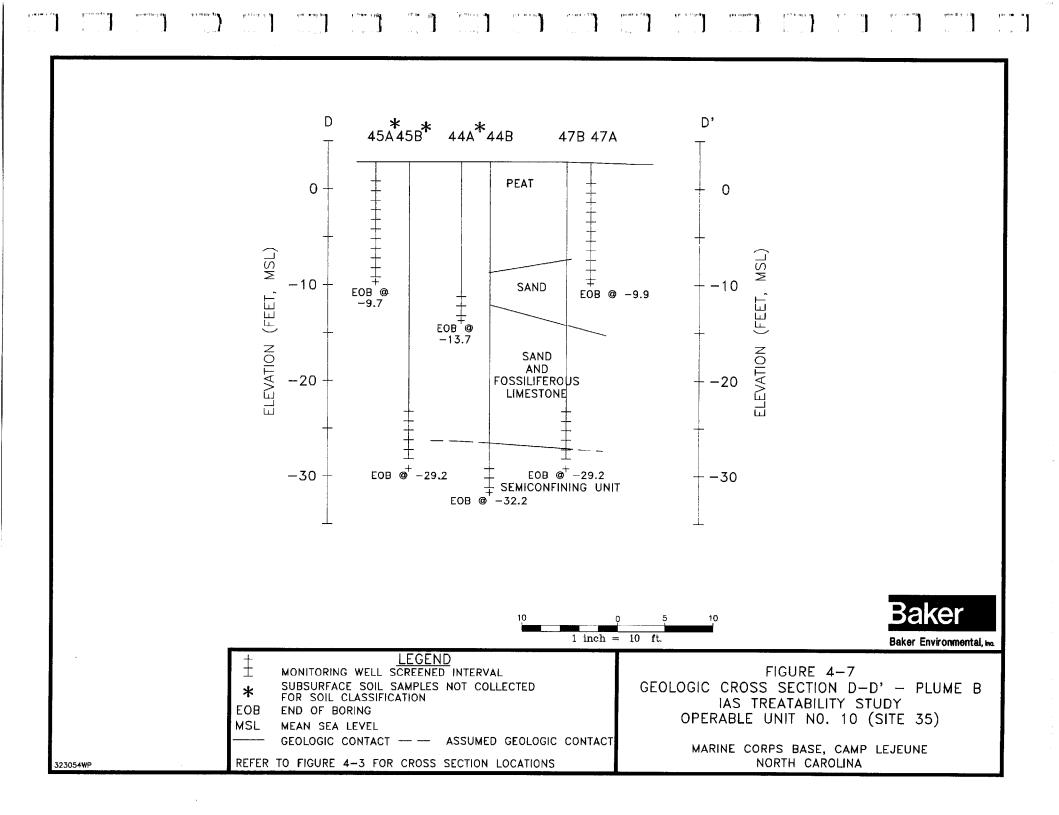


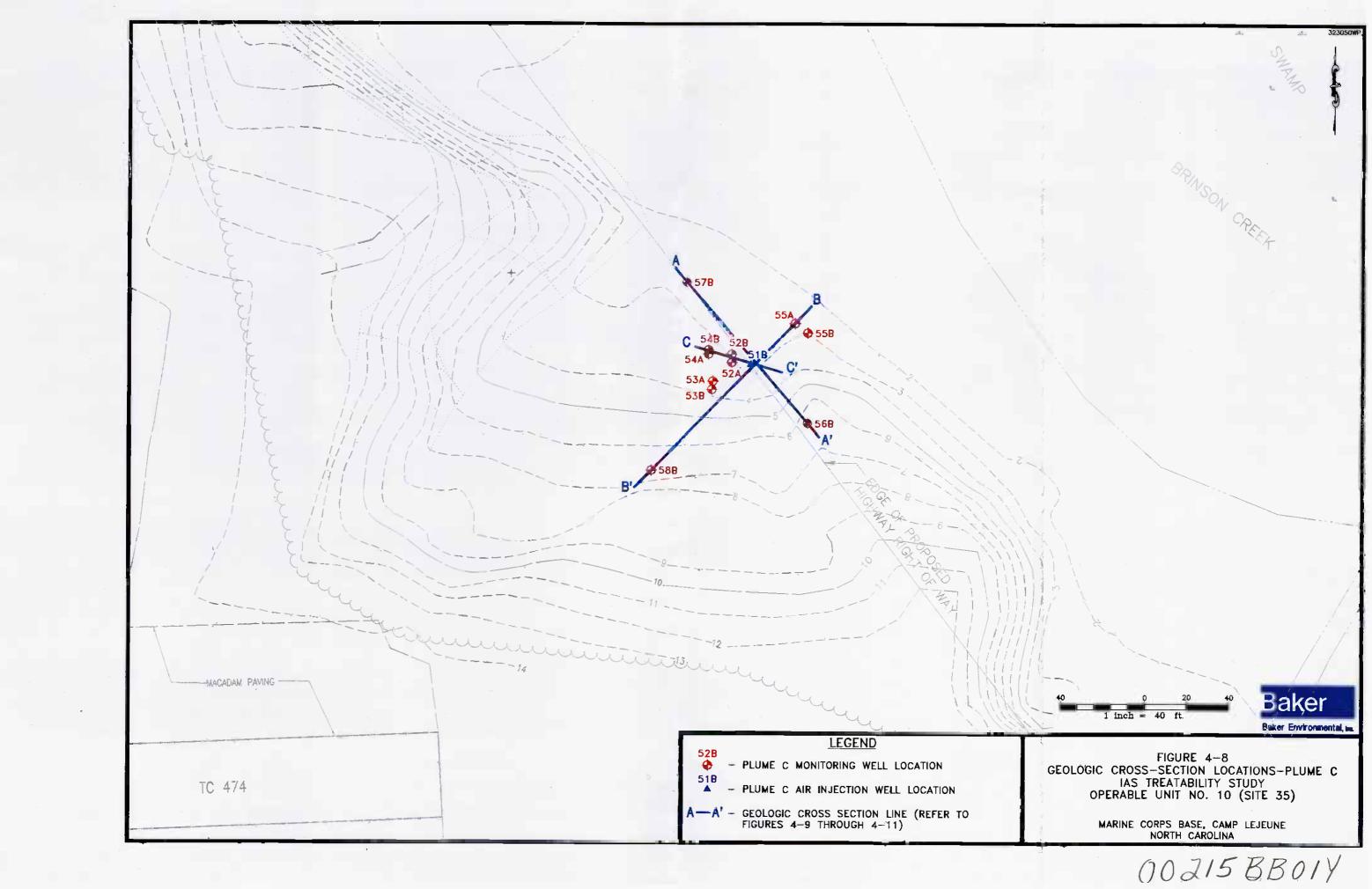


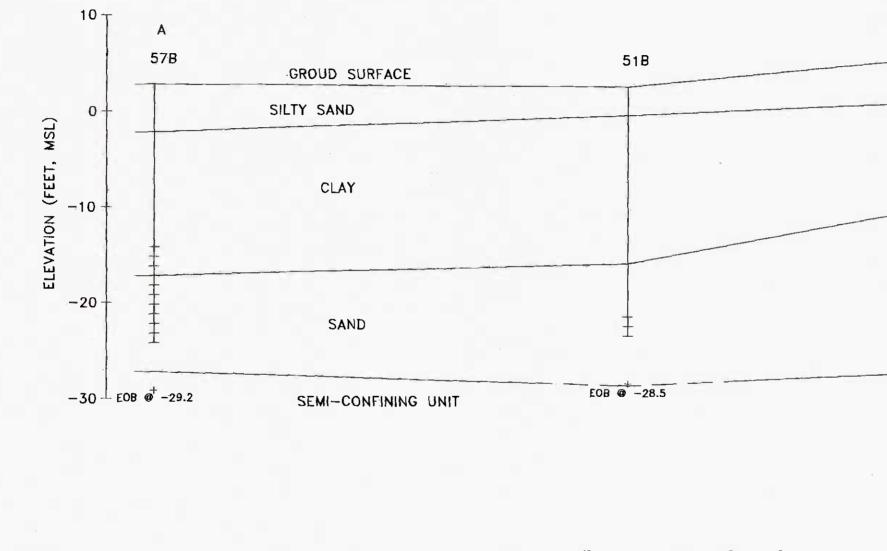
А A' 44A<sup>\*</sup>44B SG-2\* 50A SG-6 47B 46B 50B 46A 0 -0 PEAT ELEVATION (FEET, MSL) -10 - - 10 SAND +EOB @ -9.9 EOB @ -10.1 EOB @ -13.7 SAND AND -20 -20 FOSSILIFEROUS LIMESTONE + + EOB @ EOB @ EOB @ -29.1 -30 --30 -29.2 -29.2 EOB @ -32.2 SEMI-CONFINING UNIT Baker 10 10 1 inch = 10 ft. Baker Environmental, Inc. LEGEND Ŧ FIGURE 4-4 MONITORING WELL SCREENED INTERVAL SUBSURFACE SOIL SAMPLES NOT COLLECTED FOR SOIL CLASSIFICATION GEOLOGIC CROSS SECTION A-A' - PLUME B \* IAS TREATABILITY STUDY EOB END OF BORING OPERABLE UNIT NO. 10 (SITE 35) MSL MEAN SEA LEVEL GEOLOGIC CONTACT --- ASSUMED GEOLOGIC CONTACT MARINE CORPS BASE, CAMP LEJEUNE REFER TO FIGURE 4-3 FOR CROSS SECTION LOCATIONS NORTH CAROLINA 323052WP

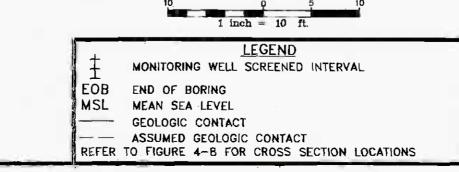


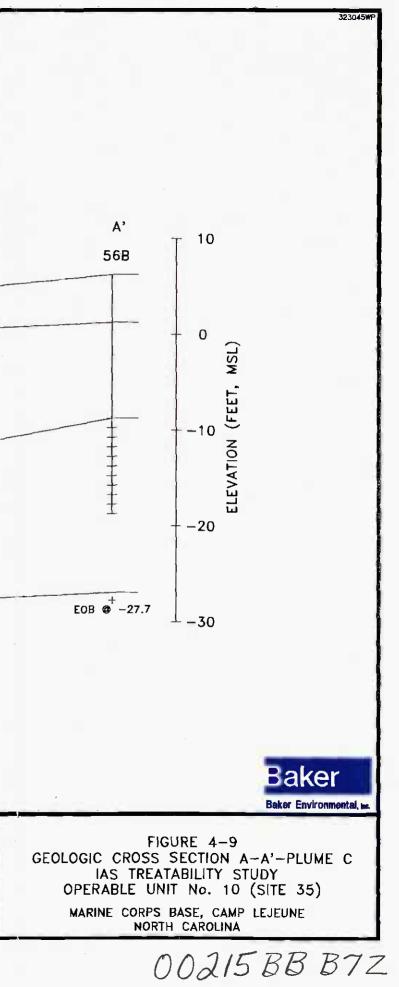
С C' 49A 49B 47B 46B 0-0 PEAT (FEET, MSL) ELEVATION (FEET, MSL) SAND -10-+-10EOB @ -10.1 ELEVATION -20-SAND AND -20FOSSILIFEROUS LIMESTONE -301 SEMI-CONFINING UNIT + EOB @ -29.7 -30EOB @ EOB @ -29.2 -29.2 Baker 10 10 1 inch = 10 ft. Baker Environmental, Inc. LEGEND ŧ MONITORING WELL SCREENED INTERVAL FIGURE 4-6 GEOLOGIC CROSS SECTION C-C' - PLUME B EOB END OF BORING IAS TREATABILITY STUDY MSL MEAN SEA LEVEL OPERABLE UNIT No. 10 (SITE 35) GEOLOGIC CONTACT ASSUMED GEOLOGIC CONTACT MARINE CORPS BASE, CAMP LEJEUNE REFER TO FIGURE 4-3 FOR CROSS SECTION LOCATIONS 323053WP NORTH CAROLINA

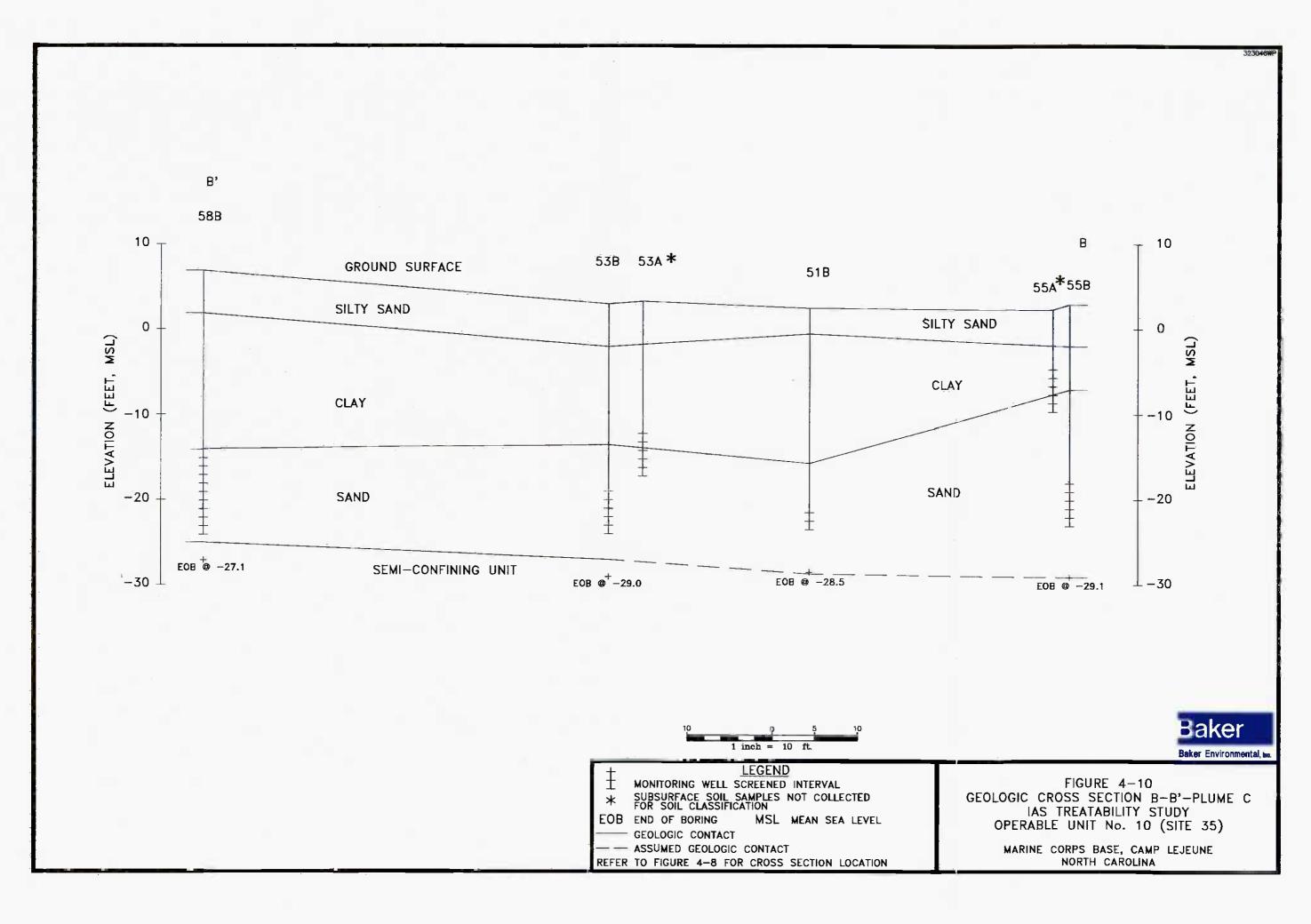


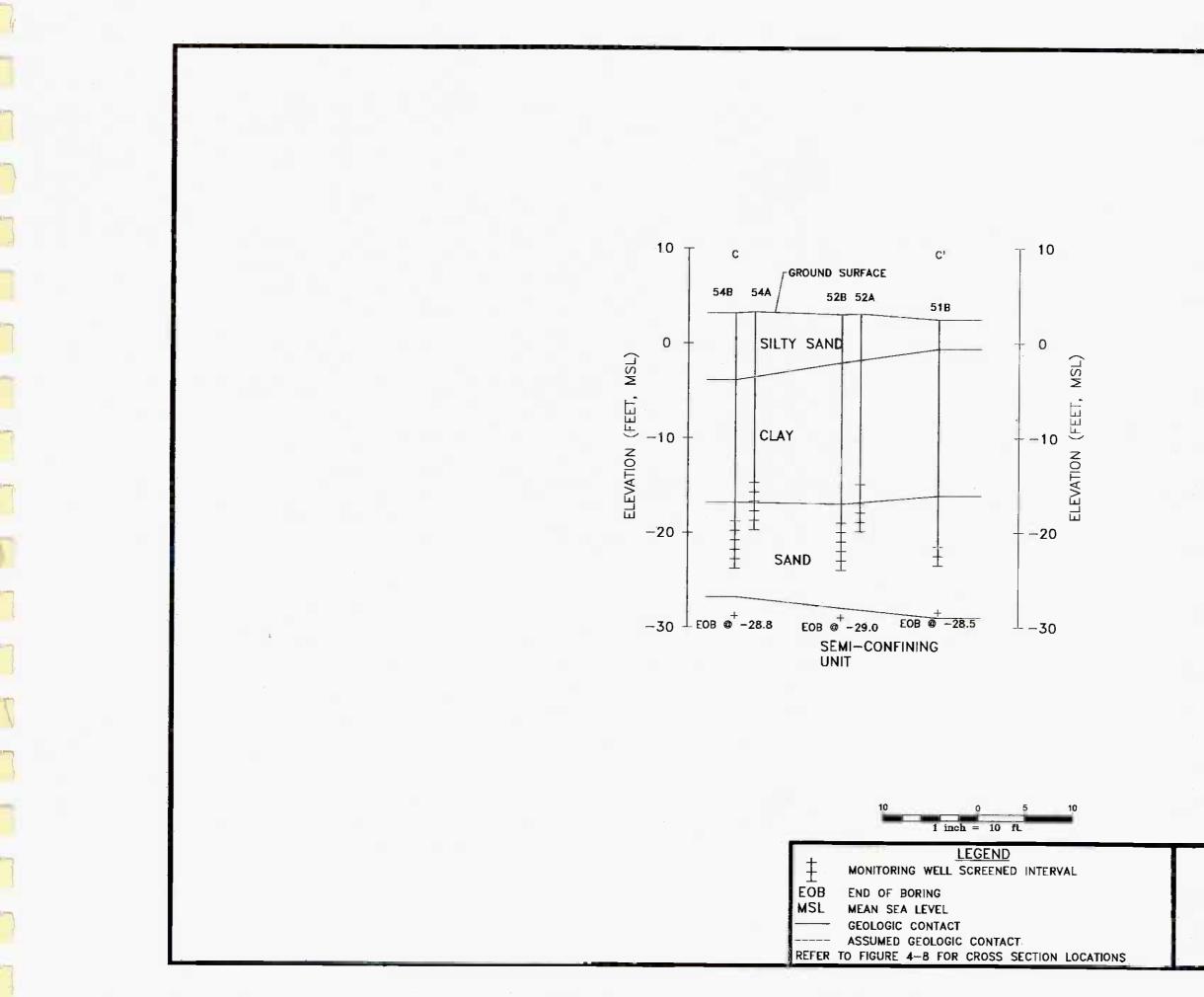














323047W

FIGURE 4-11 GEOLOGIC CROSS SECTION C-C'-PLUME C IAS TREATABILITY STUDY OPERABLE UNIT No. 10 (SITE 35)

> MARINE CORPS BASE, CAMP LEJEUNE NORTH CAROLINA

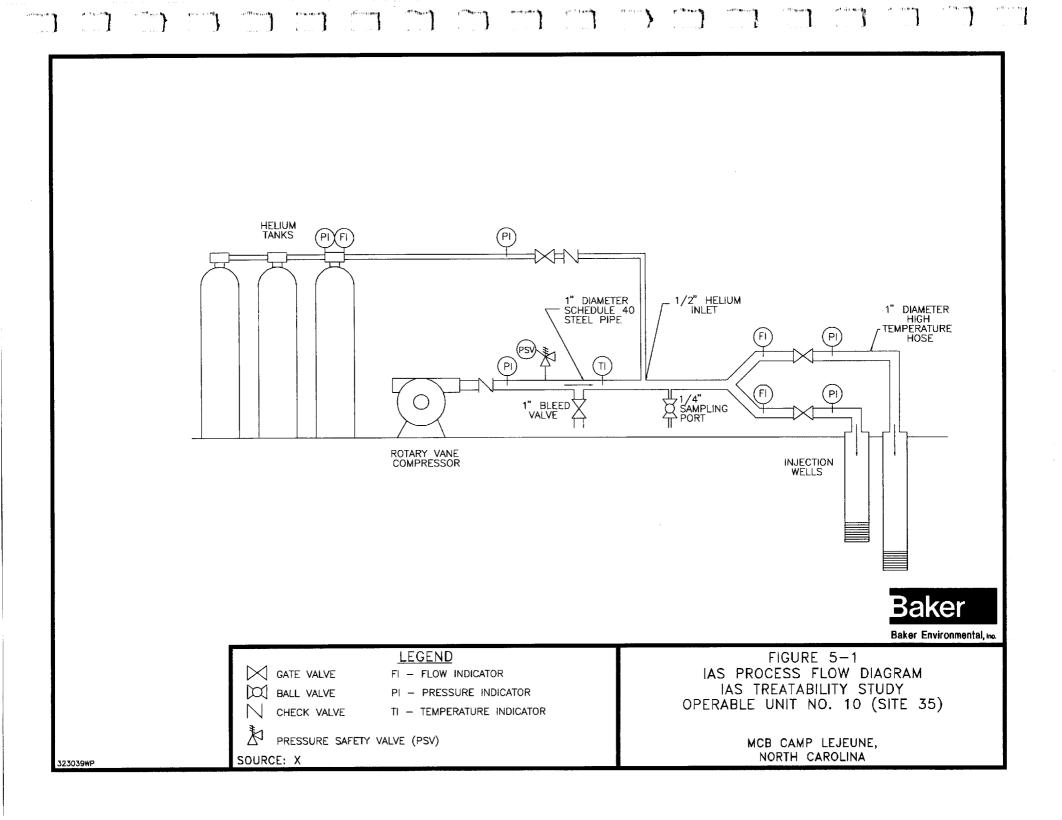
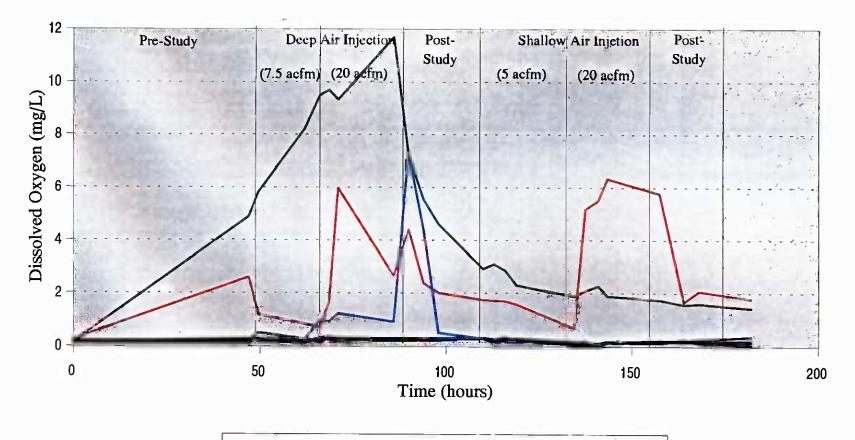
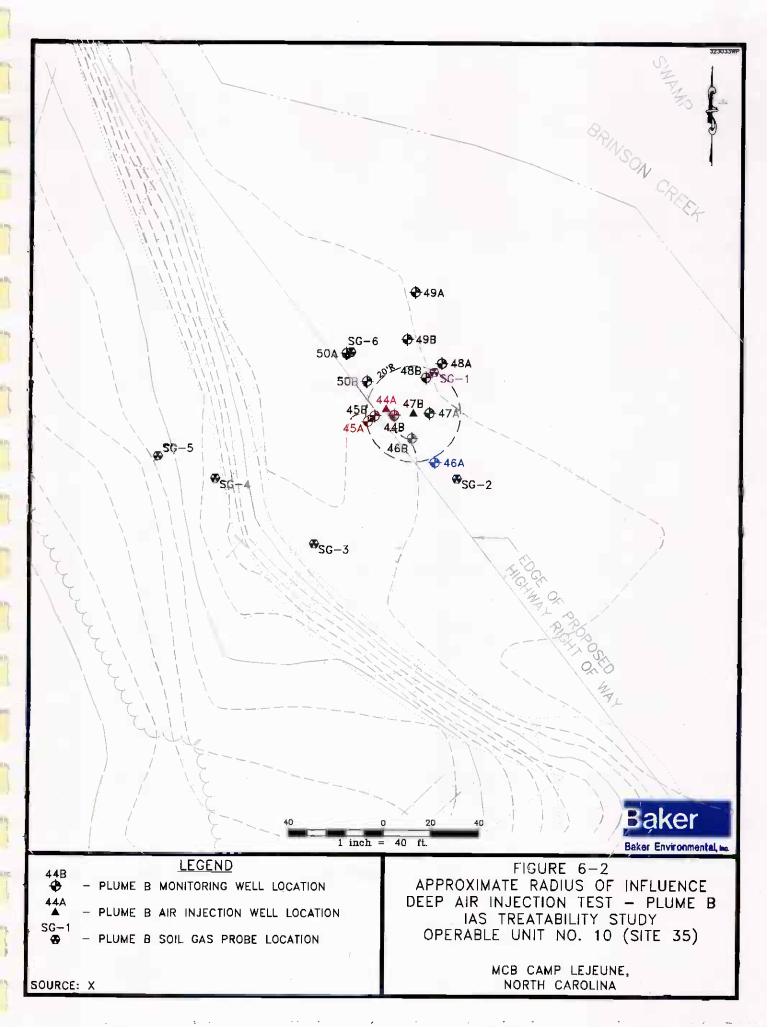


Figure 6-1 Shallow Monitoring Wells Dissolved Oxygen (D.O.) IAS Treatabillity Study Operable Unit No. 10 (Site 35) MCB Camp Lejeune, North Carolina



----- 45A ----- 46A ----- 47A ----- 48A ----- 50A

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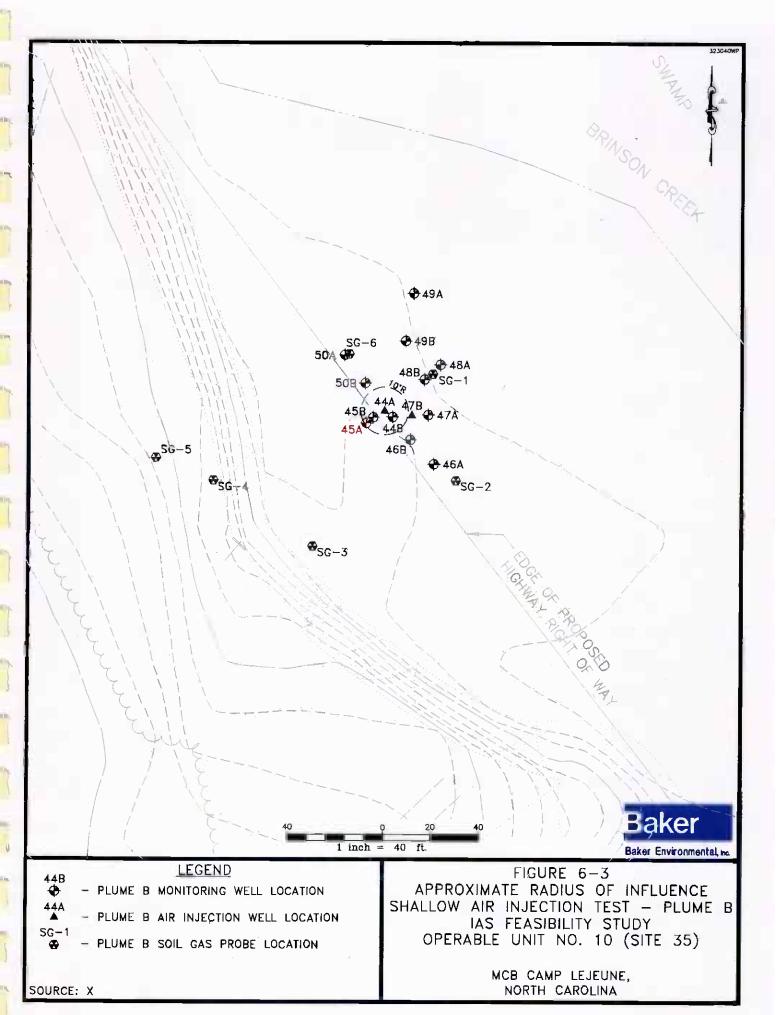
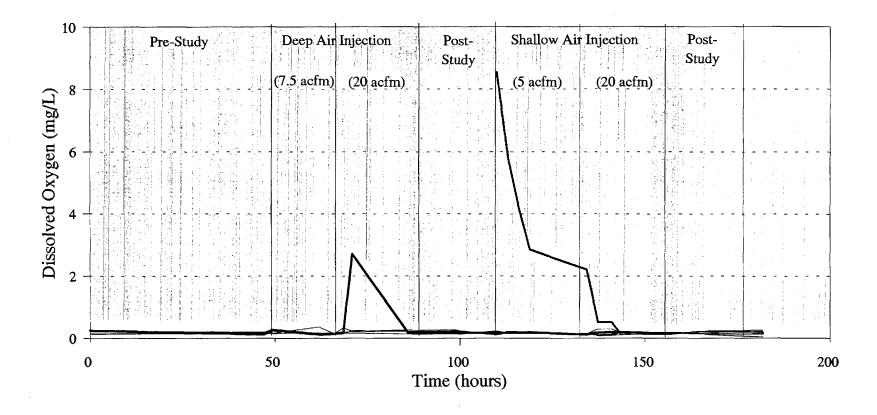


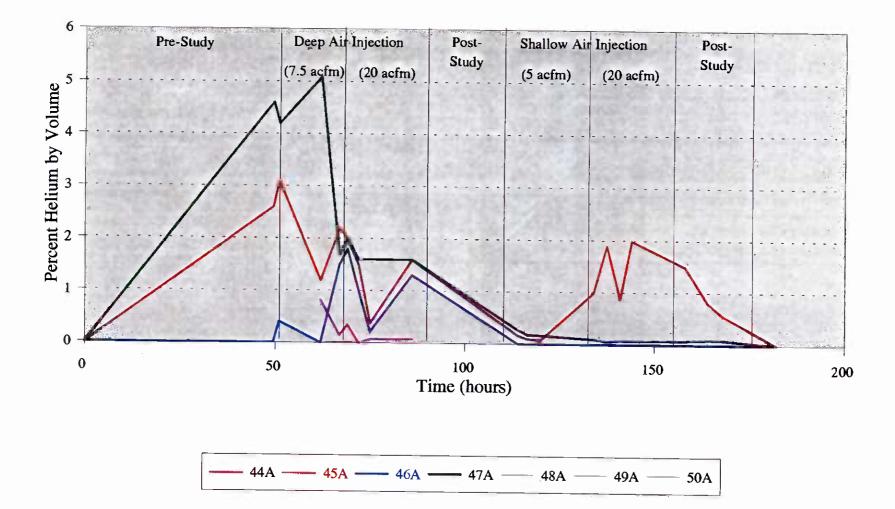
Figure 6-4 Deep Monitoring Wells Dissolved Oxygen (D.O.) IAS Treatability Study Operable Unit No. 10 (Site 35) MCB Camp Lejeune, North Carolina



----- 45B ----- 46B ----- 47B ----- 48B ----- 50B

Figure 6-5 Shallow Monitoring Wells Percent Helium by Volume IAS Treatability Study Operable Unit No. 10 (Site 35)

## MCB Camp Lejeune, North Carolina



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Figure 6-6 Soil Gas Probes Percent Helium by Volume IAS Treatability Study Operable Unit No. 10 (Site 35) MCB Camp Lejeune, North Carolina

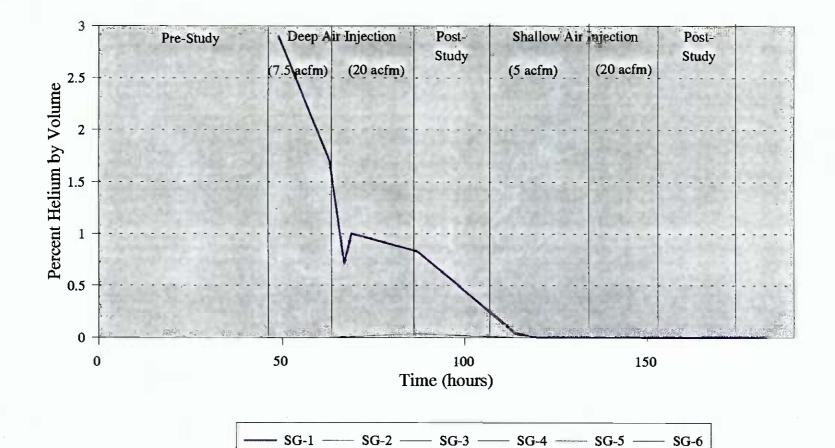
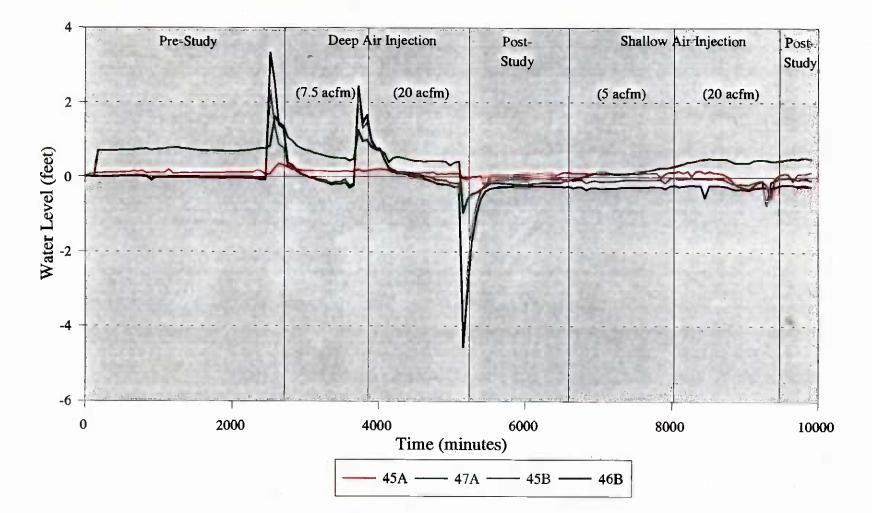
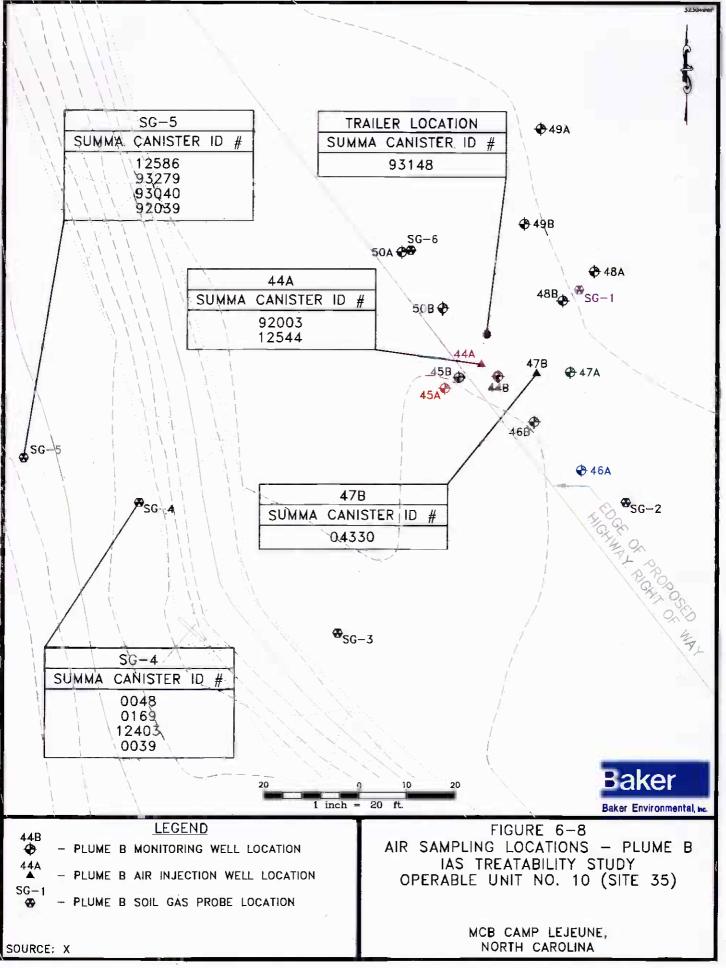


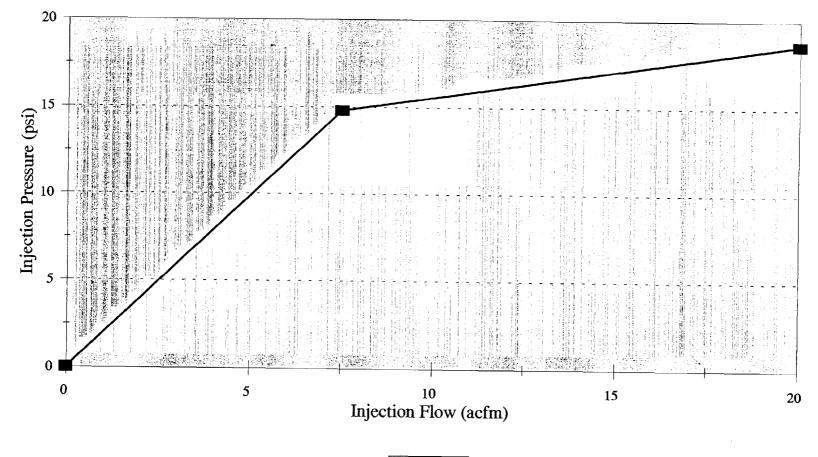
Figure 6-7 Static Water Level Readings - Plume B IAS Treatability Study Operable Unit No. 10 (Site 35) MCB Camp Lejeune, North Carolina



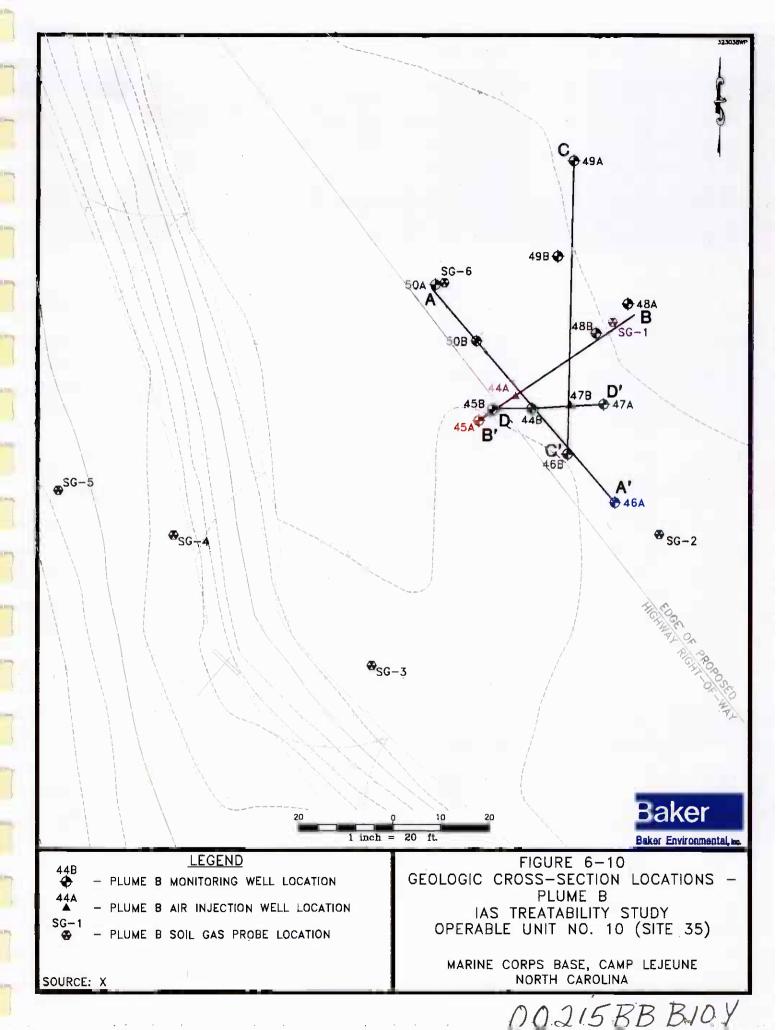


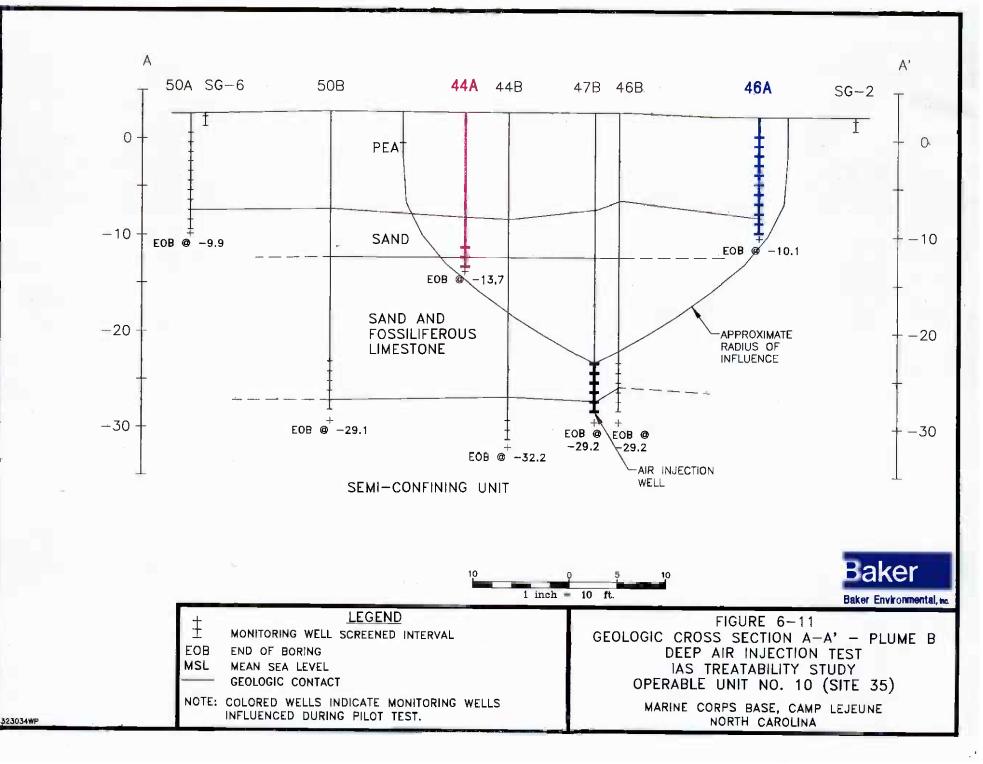
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Figure 6-9 Deep Air Injection Well - System Head Curve IAS Treatability Study Operable Unit No. 10 (Site 35) MCB Camp Lejeune, North Carolina



**-----** 47B





С C' 49B 49A 47B 46B 0-0 PEAT SAND -10-- - 10 APPROXIMATE EOB @ -10.1 RADIUS OF INFLUENCE -20+ SAND AND -20FOSSILIFEROUS LIMESTONE + -<u>30</u>1 SEMI-CONFINING UNIT EOB @ -29.7  $\pm -30$ EOB @ EOB @ -29.2 -29.2 Baker 10 10 1 inch = 10 ft.Baker Environmental, Inc. LEGEND FIGURE 6-12 Ŧ MONITORING WELL SCREENED INTERVAL GEOLOGIC CROSS SECTION C-C' - PLUME B EOB END OF BORING DEEP AIR INJECTION TEST MSL MEAN SEA LEVEL IAS TREATABILITY STUDY GEOLOGIC CONTACT OPERABLE UNIT NO. 10 (SITE 35) NOTE: COLORED WELLS INDICATE MONITORING WELLS INFLUENCED DURING PILOT TEST.

MARINE CORPS BASE, CAMP LEJEUNE NORTH CAROLINA

323036WP

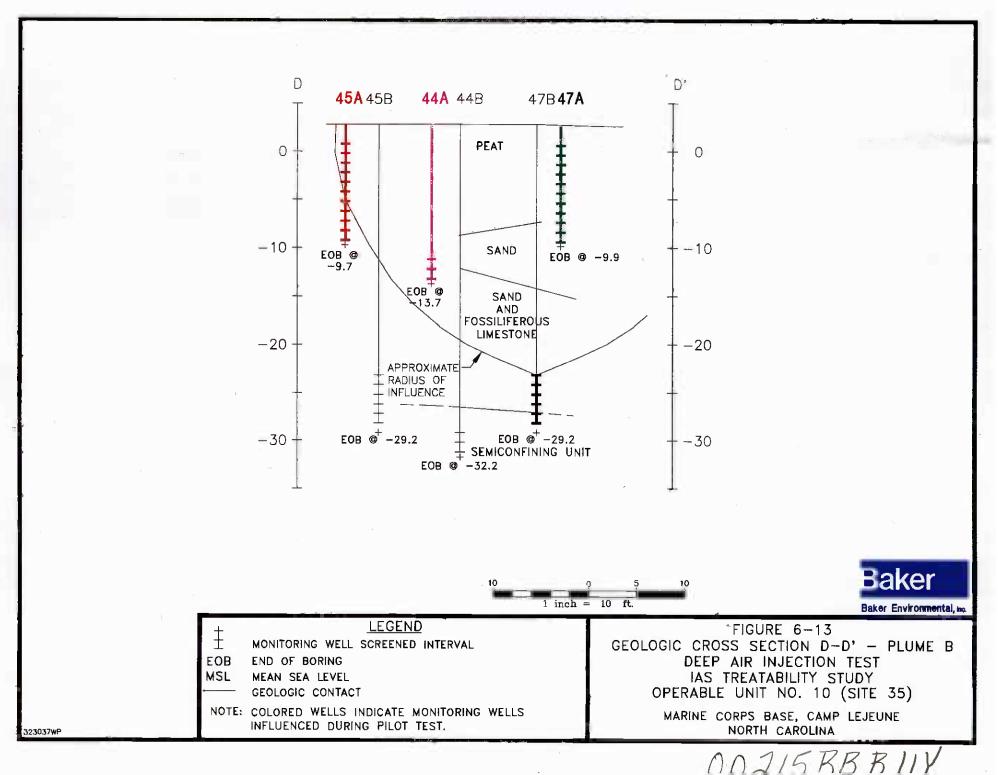
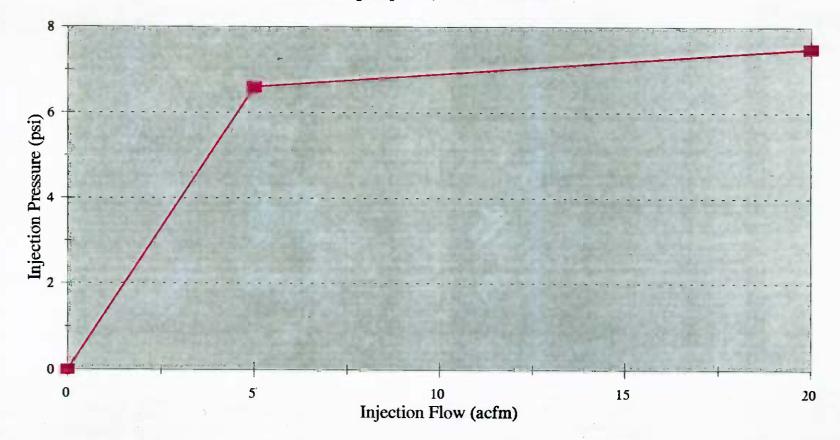
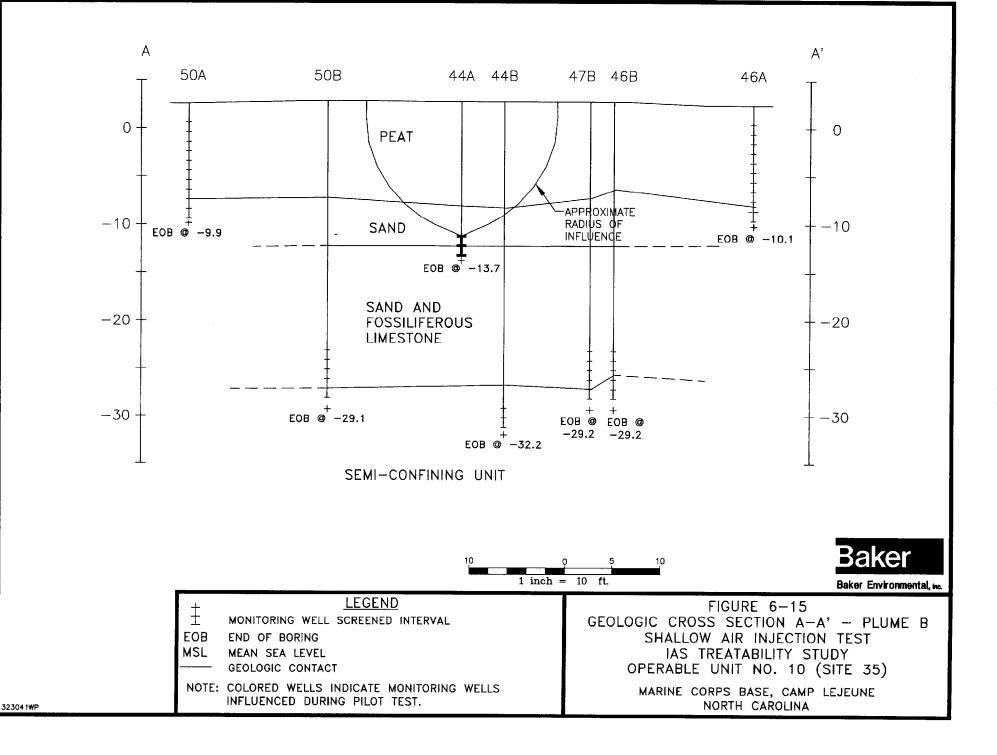


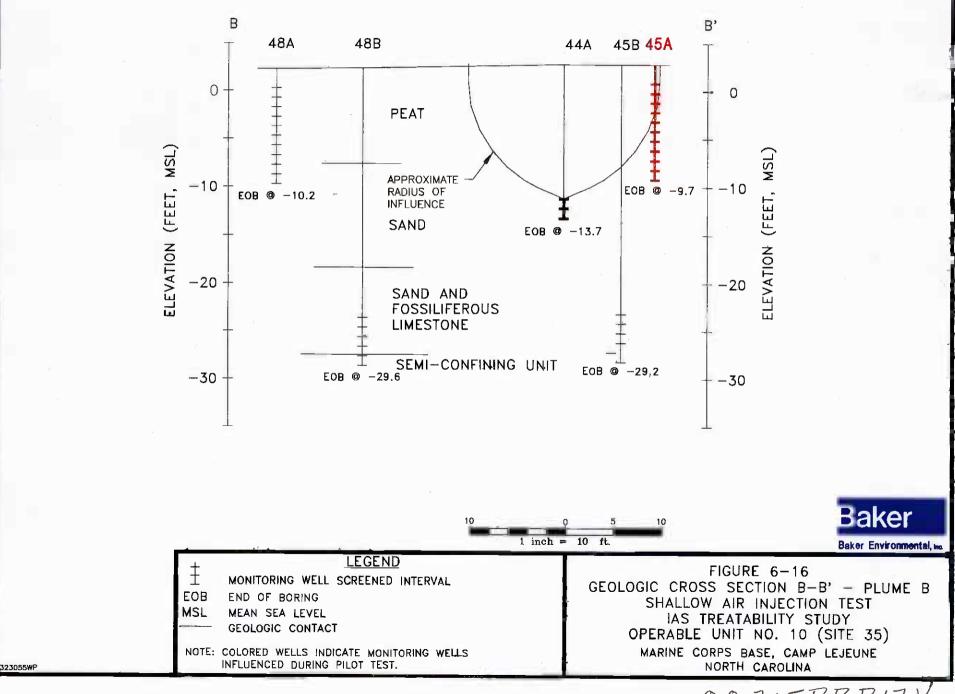
Figure 6-14 Shallow Air Injection Well - System Head Curve IAS Treatabilty Study Operable Unit No. 10 (Site 35) MCB Camp Lejeune, North Carolina



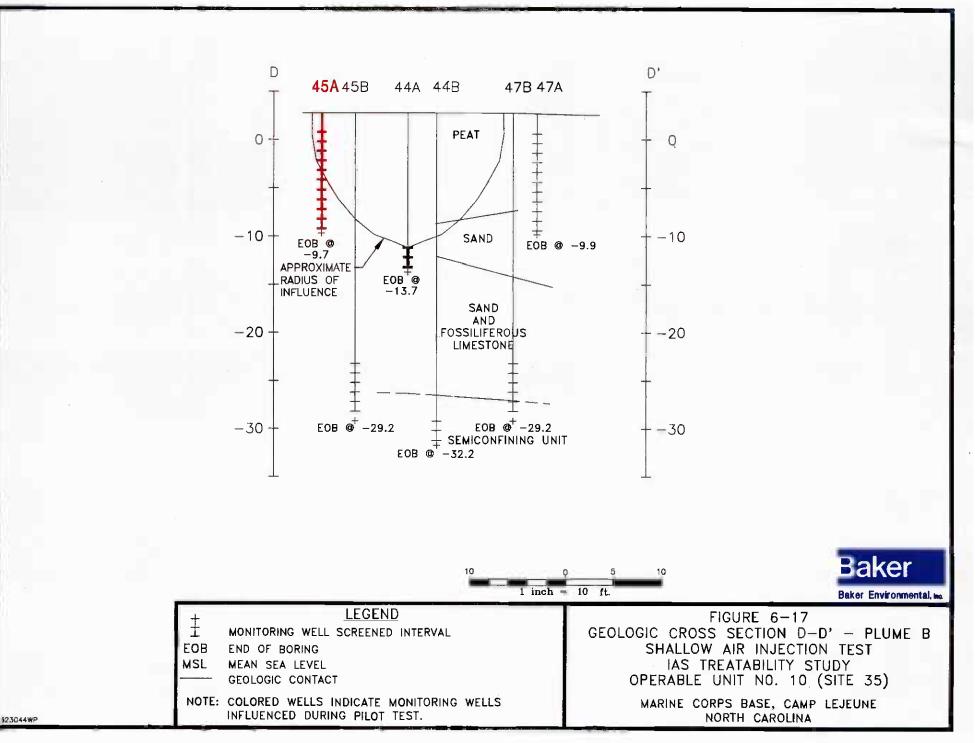


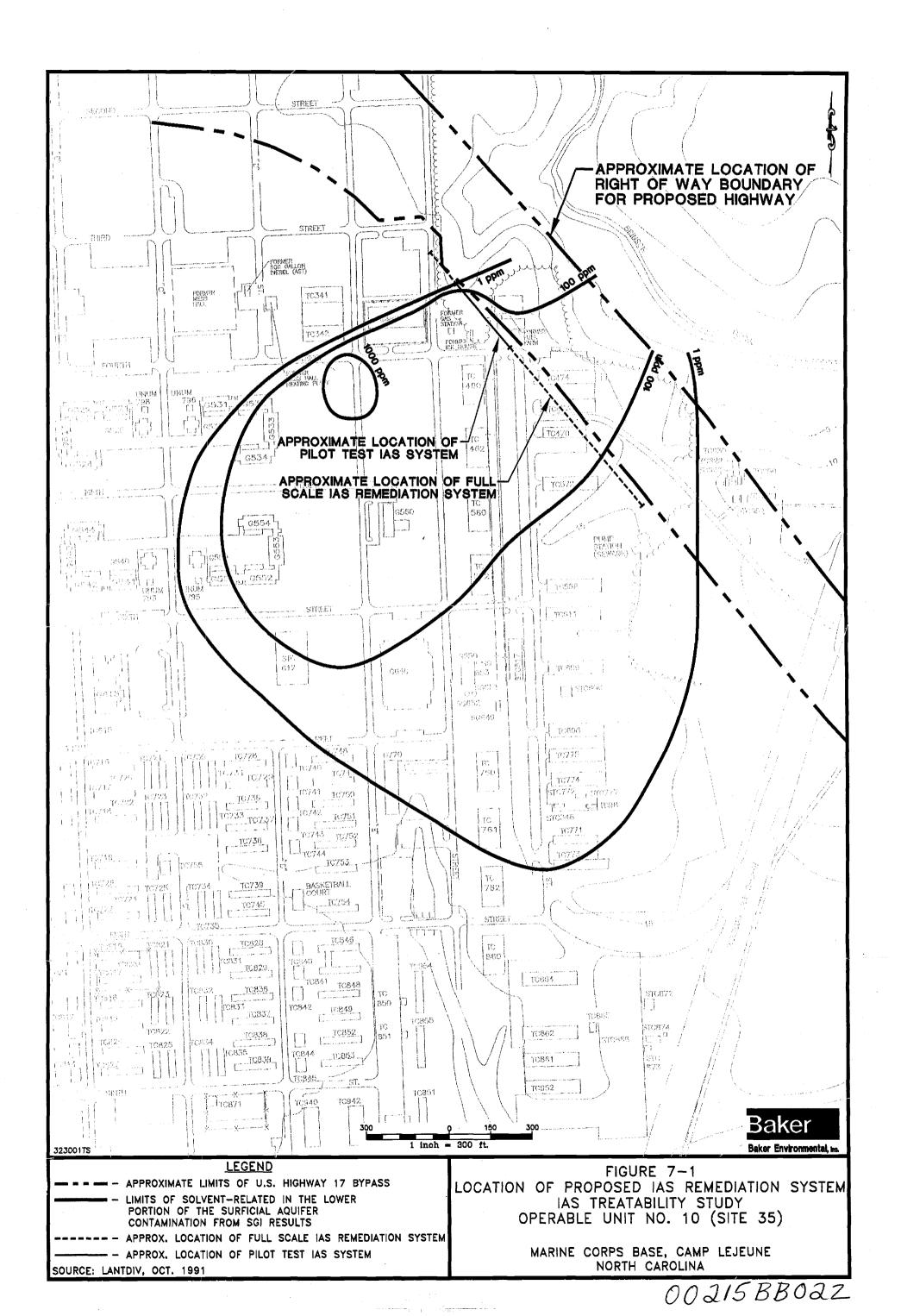


And an HULL

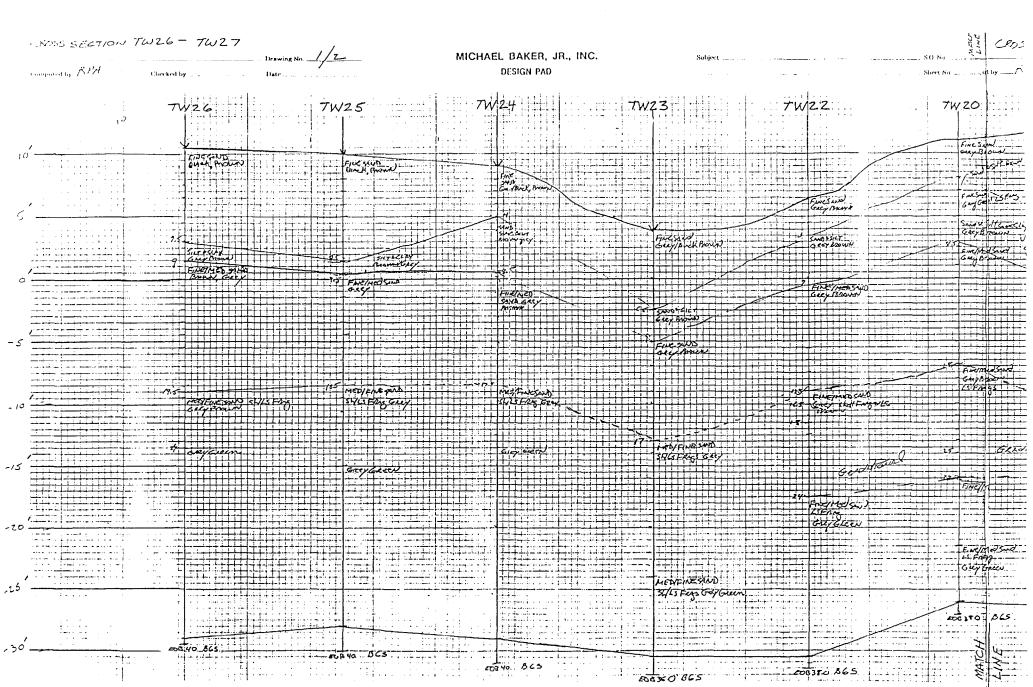


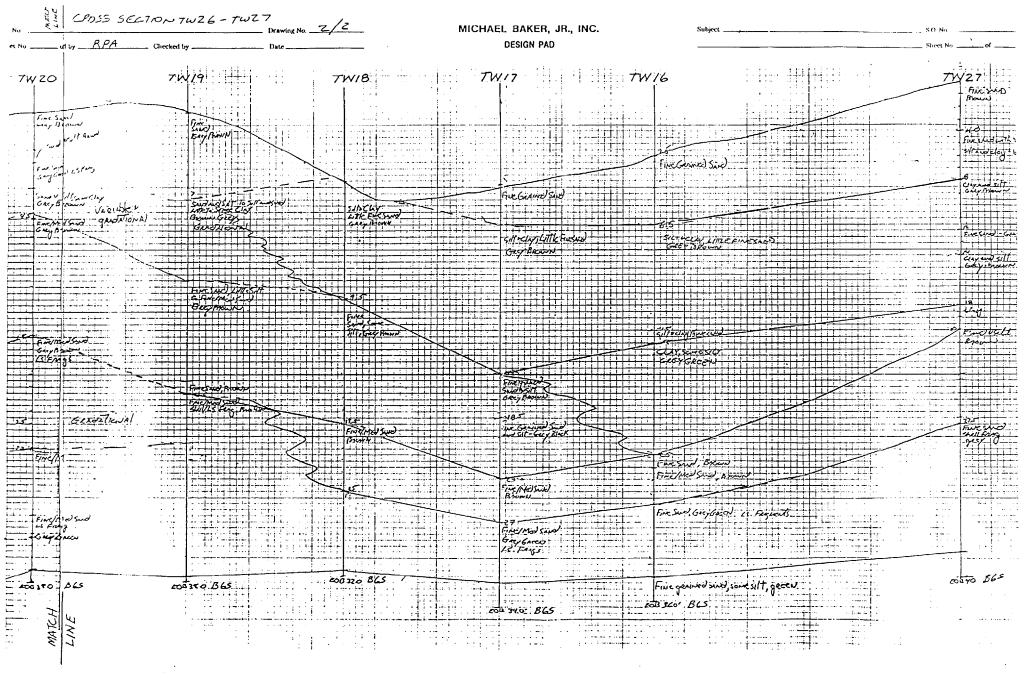
NA JISRBBIJ





APPENDIX A HYDROGEOLOGIC CROSS SECTIONS





APPENDIX B CONTAMINANT CONCENTRATION CALCULATIONS



# Vapor Emission and Resulting Soil Contomination - Site 35 IAS Allot Test

Emissions Max = 2 × W × H × Cgw ) Emission in pounds / day

where 
$$q = groundwater$$
 flow rate  $(f+|d)$   
 $w = width of IAS$  barrier  $(ft)$   
 $H = depth$  below water table to injection Soint  $(ft)$   
 $C_{gw} = dissolved contaminant concentration (16/ft2)$ 

$$H = 25 + f$$
  

$$W = 200 f f$$
  

$$C_{gw} = 6.0 \times 10^{-5} 16 / f f^{3} (\approx 1,000 \text{ mg/L})$$

 $E_{\text{missions}_{\text{max}}} = (0.06 \, f + 1 \, d) \, (200 \, f + ) \, (25 \, f + ) \, (6.0 \, x \, 10^{-5} \, 14 \, 1 \, f + 3)$   $E_{\text{missions}_{\text{max}}} = 0.02 \, 16 \, / \, d \quad \text{of contaminant}$ 

 $\begin{aligned} C_{Vapor} &= E_{missions_{max}} / R_{EAS} \quad , \quad Vapor emission contaminant concentration \\ Assume : 4 IAS wells spaced 50 ft oport with flow rate = 10 ft<sup>3</sup>/min each \\ Total Flow, R = 4 wells x /0 ft<sup>4</sup>/min/well \\ R = 40 ft<sup>3</sup>/min \\ C_{Vopor} = (0.02 H/day) / [(40 ft<sup>3</sup>/min)(1440 min/d)] \\ C_{Vapor} = 3.5 \times 10^{-7} \frac{16}{ft^3} = 5.6 \times 10^{-3} \frac{9}{m^3}, \frac{m9}{L} \end{aligned}$ 

S.O. No	
Subject: Seil-Vaser Contaminent Concerta	ation Estimates
MCB Camp Lejevine, D. V. No 10	
Site 35	
Computed by <u>GJR</u> Checked By <u>RPA</u>	Date <u>9-26-96</u>



# Vapor Emission and Resulting Soil Contamination - Site 35 Its Pilot Test

Total soil concentration,  $C_{Total} = C_{sorbed} + C_{moisture} \Theta_m + C_{uppor} \Theta_r / p_s$ where  $C_{sorbed} = C_{ontaminants} sorbed directly onto soil (mg/kg)$   $C_{moisture} = C_{ontaminants} dissolved in soil moisture (mg/L)$   $\Theta_m = soil moisture content (L-H20/Kg-soil)$   $C_{uppor} = C_{ontaminonts} in soilvopor (mg/L)$   $\Theta_v = v_{upor} void fraction$  $p_s = soil bulk density (Kg/L)$ 

In Equilibrium :  

$$C_{moisture} \times H = Cvapor$$

$$where H = Henry's Law Constant$$

$$C_{moisture} \times Kd = C_{sorbed}$$

$$where Kd = partitioning coefficient (L/Ks)$$

$$Kd = Koc \times foc, Koc = adsorption coefficient for o.c.$$

$$foc = organic corbon (0.C) content$$

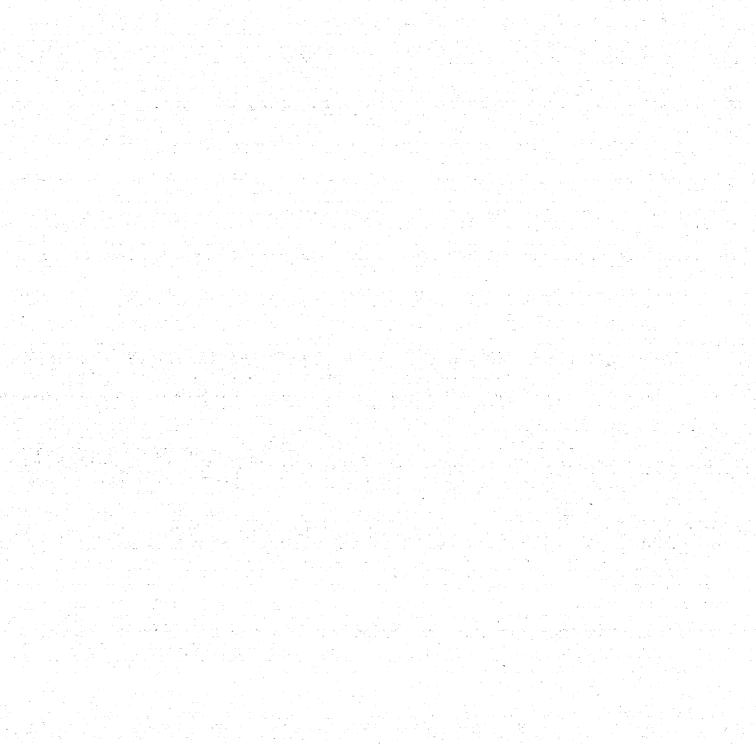
$$C_{sorbed} = Cuppor (Kd/H)$$

$$C_{moisture} = Cvopor (YH)$$

$$C_{total} = Cvopor [Kd/H + Bu/H + Bu/B]$$

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DRILLER:

#### TEST BORING AND WELL CONSTRUCTION RECORD

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PROJECT:	-	Treata	bility	Stu	SV I	m-situ	N. C	503	ipit	na Pl	une E		
CTO NO.:	-	323			·····		BORI	٩G I	NO.:		MW3544	-¥1	
COORDINAT							NORT						
ELEVATION:	: :	SURFACI	3:			<b>,</b>	тор с	)F P	VC C	CASING:	<u></u>		
<b>RIG:</b> # 82							DAT	ъ	PRO	GRESS	WEATHER	WATE	
		SPLIT SPOON	CASIN	G AU	GERS	CORE BARREL		L	(	(FT.)		(FT.)	
SIZE (DIAM	.)	1-3/8"			14"		7-11.4	16	0	-16.5	cicud 7, 80's	.5	
LENGTH		2.0		5							<u></u>		
TYPE HAMMER W	urr	Std. 140 lbs.			5 M	[					[		
FALL	v 1.	30"		_						<u></u>			
STICK UP							1						
	Aus	ered t	0 16	5.6	95) 0	lepth. 1	UKSU.	ba	e k o	irsund	is . 4 ppn	A.	
	3.3 G	split s	coord	C. A. A. A.	oles i	3 B12CU	ellec	ξe	्र				
S = Sp	-	SAMPLE	TYPE	A = A	11005	We Inform		D	iam.	Туре		Top Depth	Bottom Depth
S = Sp T = St				W = V		mom	ation					(ft.)	(ft.)
R = A	ir Rot	ary		C = C		Ris		2	2.0"	Schedul	e 40	+3.0'	-14,0
D = D		1 N = No S	amnle	P = Pi	ston			<u> </u>		PVC Schedule	- 40	1 5.0	-14.0
		14 - 140 6	anpio			Scr	een	2	2.0"	0.01 Slo		-14.0	-16.0
Depth	Samp			Lab	PIL						Well		
(ft.)	Type and		or RQD	ID No.	(ppn	1)	Visual	De	script	ion	Installati	ion	Elevation (ft. MSL)
	No.	- · ·		100.							Detail		(11.102)
								1				7 –	
												-	
2								;				-	
		· ·						•		_			
3					.4					-		anant	
											-17	′ –	
4					.4					-			
5	A-N											-	
						Y Y	luger	fc	o de	oth _	2	" PVC	
6										-		iser –	
												-	
					1			ĺ		-		—	
8										-	키니		
												_	
9								;		-			
10												-	
								Ý	Mate	h to Sheet	2	soliats	
DRILLING C	-0-	Dania	h+ _113	0165			BAK	ER	REP	T.E.	Zimmern		

6.1	Lansing	
	and the second	

BORING NO.: MW35444 SHEET I OF 2



## TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: CTO NO.:

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Treatzbility Study In-Situ Air Sparging Plume B 323

BORING NO .: MW 3544A

<u> </u>	SA	MPLE '	TYPE			DEED	NITIONS	
S = S	Split Spoc		<u></u>	$\mathbf{A} = \mathbf{A}\mathbf{u}$	ıger	SPT = Standard Penetration Test		6)(Blows/0.5')
	Shelby Tu			<b>W</b> = W		RQD = Rock Quality Designation		-
	Air Rotar	у		$\mathbf{C} = \mathbf{C}\mathbf{c}$		<b>PID</b> = Photoionization Detector		-
$\mathbf{D} = \mathbf{I}$	Denison			P = Pis	ton	<b>ppm</b> = parts per million		
		= No Sa			r			·
Depth	Samp.	Samp.	SPT	Lab	PID		Wel	1
(ft.)	Type and	Rec. (ft. &	or	ID No	(ppm)	Visual Description	Installa	tion Elevation
	No.	(II. & %)	RQD	No.		-	Deta	
	110.	/0)				Continued from Sheet 1		
								Bantonita
								pallets
12								
	14 . 1							2" PVC
13	AN	-			.4			riser
					1.4	Auger to depth		Sand
14						4	-3-2-	pack
15						:		well
						; 1		Screen
16								-
Kas						i v		
17						End of Barring		weit
						End of Boring TD: 16.5' (bgs)	$\neg   \neg \uparrow$	plug
18						TD: 16.5 (bas)		'
19								
20							_	
21								- 1
		` I						I
22							-	
]								
23								
24								
		1						!
25								
26								-  1
						-		I
27							-1	
						-	-	- 7
28							1	- 1
	1					-		<u> </u>
29						-		
30								
. NU 1 1								1
50	l	1						

DRILLER:

G. Lansing

BORING NO.: MW3544A SHEET 2 OF



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# TEST BORING AND WELL CONSTRUCTION RECORD

Baker Environmen												
PROJECT:	Tre	<u>zatabil</u>	ity st	udy.	In S	itu Air	Spars	<u>ing</u>	Plan	<u>e 2</u> 	48	
CTO NO.:		23					BORING NORTH:	NO.:				
COORDINATI	ES: EA	ST:						PVC C	ASING:			
ELEVATION:	30	KFACE.										<del></del>
RIG:											WATER	
# 82							DATE		)GRESS (FT.)	WEATHER	DEPTH	TIME
		PLIT	CASING	AUG	ERS	CORE			(11.)		(FT.)	
		-3/8"					7-14-90		- 35.0	Narcast, rain (Bo's)	-5	11
SIZE (DIAM. LENGTH	<u>,   -</u>	2.0		<u>67</u>			1-14-1	<u> </u>				
TYPE		Std.		HS HS			<b> </b>	1				
HAMMER W		40 lbs.			<u> </u>							
FALL		30"										
STICK UP											<u> </u>	
REMARKS:	Borel	nota a	entim	13051	y Ea	implad	10 3		o' (bgs	) depth.	HNU	
	back	Jiam	10 6 m	~30-	1 *	1 200 -	h have	Diam.	Туре		Тор	Bottom
		MPLE '		A = Au	aer.	We		Jam.	Type		Depth	Depth
	olit Spoo nelby Tu			$W = W_{t}$	-	hittin					(ft.)	(ft.)
	ir Rotar			C = Cor		Ris	er	2.0"	Schedul	e 40	+ 3.0	-320
D = D	enison			$\mathbf{P} = \mathbf{Pist}$	on				PVC	- 40		200
	N	I = No Sa	ample			Scr	een	2.0"	Schedul 0.01 Sic		-32.0	-34.0
Donth	Samp.	Samp.	SPT	Lab	PID				1	Wel		L
Depth (ft.)	Type	Rec.	or	D	(ppm)		Visual D	escrip	tion	Installa	tion	Elevation
	and	(ft. &	RQD	No.	1		( waar 2	F		Deta	il	(ft. MSL)
	No.	%)	┨			_				1/17	$\nabla$	
	N-N		-		.4	-			-	JIT		
1		.3,									4	
2	S-1	.3/2.0	WOH		.4				-			
	5		24"		.4						4	
3 3.0		15%							-		coment	
		.4.	1.2.41			PER	IT MAT	Foini	w	+ A	grout -	
4	5-2	2.0	120H		.4.	1	compose		-			
		20%	24		.4		-		ATERIA			
5 _ 5.0						Da	rk brow	on, i	ser 4		_	
6		.8	WOH		4	10	ase, u	set			_	
	5-3	2.0	24		.4						2" PUC	
77.0		40%	•							- 4	riser_	
		1.0								11	-	
8	5-4	2.0	WOH		17					-11		
		50%	1		.4							
9 <u>9 9.0</u>		1.0	°									
10	5-5		WOH		.4					111		
	1	50%			1.4	-		Ma	tch to Shee	et 2		
					-							

DRILLER:

DRILLING CO .: Partatt - Wolff BAKER REP .: J.E. ZIMMERMON G. Lawring BORING NO .: MW3544 E SHEET I OF 3



#### TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: CTO NO.:

Ι,

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Trantability Study In-Silu Air Sporping Plume B 323 BORING NO .: MW3544 B

T = 5 R = 4 D = 1	Split Spoo Shelby Tu Air Rotar Denison N	ıbe		A = Au $W = W$ $C = Co$ $P = Pis$	ash re ton	DEFINITIONS SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5') RQD = Rock Quality Designation (%) PID = Photoionization Detector ppm = parts per million								
Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)						
11	5-5	50%	1:1E		· A./.A	Continued from Sheet 1		T						
12	5.6	N N N	Wolf 12		.4	SAND, fine grained wil _ trace silt, little								
13/30		65%		1	.4-	decomposed wood - splinters. Brown, -	Cerner	rt l						
14	5-7	20		•	.4	- stace, szeat yrak	grout	-						
15		80%			.4	_								
16	5.8	0.5	2 4 2		.4	SANDD, fine to medium grained, trace sitt, comented - Shell material, trace shell	2" AVC							
17		80%	21		4	fragments. Orange (Brownish Staining, Brown Marowish Brown and Wakita, medium	4 riser							
18	5.9	1.8	25 25 25		.4	densa. wet.		l.						
19		90%	19 38		4			<b>—</b>						
20 _	5-10	0/20	14		4.4	SAND, fine grained, _ trace sitt, little _		L.						
2121.0		50%	1015		4-	comented sandstone- nodules, trace shalt		T						
22 _	5-11	1.2	11 15		.4	material (shell -								
23230		60%	21 21		4	fragments. Brown / Yellowish brown / light								
24	5-12	2/0	00		.4	greenish gray to light_ gray and ushite, _								
25		50%	13		4	dansa (medium dansa, wet		1						
26	5-13	1.4.	190		-4.	FOSSILIFEROUS LIMESTONE WISMND, Fine grained,								
27		70°/0	18 23		.4-	trace silt, little shall material (shell frag- ments, micrite (matrix).		. J.						
28	S-14-	0 1 si	19	: :	.5/	Light gray and white danse to madium danse		Ţ						
2929.0	[	80%	13			uset	Bento Potto	nita 🔫						
30	5-15	1.8/2.0	13 10		-5/5									
DRILLING (	co.: _ <u>T</u>	arrat	<u>t-w</u>	olff		BAKER REP.: $J. E. Z$	immerman							
DRILLER:	G	.Law	ina			$\underline{\qquad} BORING NO.: \underline{M} W 3$	<u>5448</u> Sł	IEET 2 OI						



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#### TEST BORING AND WELL CONSTRUCTION RECORD

Baker Environmental, Inc Treatability Study In-situ Air Sparging Plume B 323 BORING NO: MULISA PROJECT: MW3544R CTO NO .: SAMPLE TYPE DEFINITIONS S = Split Spoon  $\mathbf{A} = Auger$ SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5') **RQD** = Rock Quality Designation (%) T = Shelby Tube W = Wash $\mathbf{R} = \operatorname{Air} \operatorname{Rotary}$  $\mathbf{C} = \mathbf{Core}$ **PID** = Photoionization Detector  $\mathbf{P} = \mathbf{Piston}$ ppm = parts per million  $\mathbf{D} = \mathbf{Denison}$ N = No Sample Depth Samp. Samp. SPT Lab PID Well Rec. ID (ppm) Elevation (ft.) Туре or Visual Description Installation (ft. & RQD No. (ft. MSL) and Detail No. %) 108 Continued from Sheet 2 .5/.5 5-15 90% 31 310 SAND, Fine grained, 5 2" PUC 2.0 5/5 trace sit, trace clay, 15217 SWQ DWS 32 2.0 5-16 trace shall material, Sand 100% trace fossilitarous pack 33.0 33 limestone, micrite .5/ 5.0 weil (matrix). Greenish 34 2.0 Screek 5-17 S 100% 35 35.a End of Boring wall 6 plug-TO: 35.0' (bgs) 7 8 9 0 2 <sup>i</sup>3 1 :5 :6 7

DRILLING CO .: Parratt- Wolff J.E. Zimmerman BAKER REP.: G. Lansing BORING NO.: <u>MW 35448</u> SHEET 30F 3 DRILLER:



#### TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT:		Treat	abilit	y Stu	dy I.	n-situ					lume E		
CTO NO.: COORDINA	TEC.	<u>323</u> EAST:					BORIN		NO.:		MW3545	H	
ELEVATIO		SURFAC	E:						vco	CASING:			-
222		Solutio					101 0						
RIG: # 82							DAT	ъ	PRO	OGRESS	WEATHER	WATE	
		SPLIT SPOON	CASIN	G AU	GERS	CORE BARREL			1	(FT.)		(FT.)	
SIZE (DIA)	M.)	1-3/8"		6	/4.''		7-11-96 0-12.5			12.5	cronger 80.2	-5	<b></b>
LENGTH		2.0		3									
TYPE		Std.		14	SA								
HAMMER	WT.	140 lbs.				100-10-00-00-00-00-00-00-00-00-00-00-00-					1		
FALL		30"					·····		Winter and a state			1	
STICK UP													
REMARKS	Marc	ierza -	10 12.	5116	os de	nthe b	4830	10.0	c la	31.40.00	d is . 4pp	<u> </u>	
	No	split	5000	sin Sa	mpla	5 USER	. d. C	)/L	с. с. <sup>1</sup>	10.5			l_
		SAMPLE	TYPE			We	1	Di	am.	Туре		Тор	Bottom
	Split Sp Shelby			$A = A_{1}$ $W = W$		Inform	ation					Depth	
	Air Rot			C = Cc						Schedule	40	(ft.)	(ft.)  _
	Deniso			P = Pis		Rise	er	2.	.0"	PVC	; 40	+2.0	-2.0 -
		N = No S	ample							Schedule	40		
				Screen 2.0			.0"	0.01 Slo		-2.0	-12.0		
Depth	Sam	o. Samp.	SPT	Lab						Well	<u> </u>	 	
(ft.)	Тур	1	or	ID	(ppm)	1	Visual	Des	crinti	on	Installat		Elevation
	and	- i `	RQD	No.			Visual Descrip				Detai		(ft. MSL) '
	No.	%)						1			- 10x41 10x51 T	7	<b>-</b>
										-		<u> </u>	
										_		Benton	de
2										-		pallet	
													L.
3										-		-	
				5 - -								-1	
4					.4					-		-	l
	AX	) _			1.A						1 -	-	
5					1.4					-		sand	-
						A,	nger	to	da	oth -		pack	
6							J		1	-	下國	7	
						1							-
7										-		1	
8							:			-		JOUL -	
								ĺ		_		creev	.1.
9					1						該田毅		<u> </u>
								Į					
10													l
							N	N	latch	to Sheet 2	26日間		
		Der	11 10	-100			DAVE	n n			~~~,	1	
DRILLING (				1017 1			BAKE				Zimmeri		
DRILLER:	-	G. Lav	ising				BORIN	4G I	10.:	MW3	5451	SHE	ET I OF 📥



PROJECT: CTO NO.:

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#### TEST BORING AND WELL CONSTRUCTION RECORD

Treatability Study In-situ Air Sparging Plume B 323 BORING NO .: MW3545A

	SAMPLE TYPE DEFINITIONS												
	plit Spoo			A = Au		SPT = Standard Penetration Test (A	ASTM D-1586)(Blows	s/0.5')					
	Shelby Tu			W = W		<b>RQD</b> = Rock Quality Designation (	%)						
	Air Rotar Denison	y		C = Co P = Pis		<b>PID</b> = Photoionization Detector <b>ppm</b> = parts per million							
		= No Sa	mple	1 113	ton								
Depth	Samp.	Samp.	SPT	Lab	PID		Well						
(ft.)	Туре	Rec.	or	ID	(ppm)	Visual Description	Installation	Elevation					
	and No.	(ft. & %)	RQD	No.			Detail	(ft. MSL)					
						Continued from Sheet 1	5and						
11					.4		B- Pack						
	A-N	-			1.4	Auger to depth .	No well						
12						—	-Serae	.n					
13					**************************************	End of Boring _							
					ļ		weit						
14	-					TD:12.5'(bgs) -	plug						
15						-	4       -	:					
					1	-							
16						_							
., -							$\left\{ \left  \right\rangle \right\} \left\{ \left  \right\rangle \right\} $						
17						_							
18													
_													
19						_							
20						-	4       -						
						-							
21						_							
22													
							+ $+$ $+$ $+$ $+$						
23						-							
24						-							
25						-	4						
						_							
26						-	4111 —						
27					[	.	4         4						
					1	-	1       -1						
28													
					1		4						
29													
30							]						
DRILLING C	20.: <u>R</u>	terne	<u>c-Wo</u>	net		BAKER REP.: $J. \epsilon$ .	Zimmerman						

G. Lansing

BORING NO.: <u>MW3545A</u> SHEET 2 OF 2



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#### TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: CTO NO.: COORDINAT ELEVATION:	ES: E/	3 <u>23</u> AST:	3:				BORIN	IG NO. H:	CASING:	Mu	1354-9	5 <u></u> 8	
RIG: # 82		PLIT				CORE	DAT	E PF	ROGRESS (FT.)	WEA	THER	WATER	
		POON	CASIN	G AU	GERS	BARREL			()			(FT.)	
SIZE (DIAM	.) 1	-3/8"		61	14"		7-144	76 C	-32.0	overca (70's	ast, haz-r	- 5	
LENGTH		2.0			5								
TYPE		Std.		1-15	51								
HAMMER W	VT. 14	40 libs.											
FALL		30"					<u> </u>	_ _		<u> </u>			
STICK UP													
S = Sp	Nos	<u>p/:+_3</u> MPLE n	Pool	A = Ai $W = W$	uger	We Inform	<u>اا</u>	Diam		t	φιτη 	Top Depth (ft.)	Botto Dep (ft.)
	ir Rotary			C = Cc				2.0	Schedu	e 40			
D = D	enison			P = Pis	ston	Ris	er	2.0"	PVC			43.0	-261
		[ = No S	-			Scre	en	2.0"	Schedul 0.01 Slo			-26.0	-3(
Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)		Visual	Descrij	otion		Well Installati Detail	on	Elevati (ft. MS
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	M-N	-			5/3	Auc	jer to		- 		2	ement growt	-
<u>_</u>	****	I	J		_1							l.	
DRILLING C				144				er rep			marv		
ORILLER:		P. Can	Sing				BORI	NG NC	): <u>Mu</u>	254	-SP	SHE	ET I C

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Baker Environmental, m

# TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: CTO NO .:

Treatzbility Study In-situ Ait Sparging Plume B 323 BORING NO.: MW3545B

T = 5 R = 7 D = 1	Split Spoo Shelby Tu Air Rotar Denison N	ibe y = No Sa	mple	A = Au $W = W$ $C = Co$ $P = Pis$	ash ore ton	DEFINIT SPT = Standard Penetration Test (A RQD = Rock Quality Designation (9 PID = Photoionization Detector ppm = parts per million	STM D-1586)(Blow	's/0.5')
Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
11         12         13         14         15         16         17         18         19         20         21         22         23         24         25         26         27         28         29         30	А N N Со.: Р			sift	.6/.6	Continued from Sheet 1 Flugar to 13.0' (bgs) V Drill to depth BAKER REP: J.E. Z	pell Savel pack Useri Scree	shite ets
DRILLER:	Ċ	5. Lan	sing			$\underline{\qquad} BORING NO.: \underline{MW3}$	<u>5458</u> s	HEET 2 OF

Baker Baker Environmental, Inc.

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#### TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: Tr CTO NO.:

Treatability Study In-situ Mir Sparging Plume B 323 BORING NO.: MW3545B

T = She	<u>SAMPL</u> it Spoon elby Tube	<u>e type</u>	<b>A</b> = Au <b>W</b> = W	ash	DEFINITIONS SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5' RQD = Rock Quality Designation (%)						
R = Air $D = De$	Rotary		C = Co P = Pis		PID = Photoionization Detector ppm = parts per million		T T				
D = De	N = No	Sample	r - ris	lon	ppin – parts per minion		I.				
	Samp. Samj Type Rec and (ft. & No. %)	o. SPT or	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)				
32	N _	-		.6/.6	Continued from Sheet 2 Drill to depth End of Boring	Screat Screat Sand pack	~ T				
<sup>33</sup> 34					TD: 32.0' (bgs) -	plug_					
35 _											
6 7							4. •				
					-		I.				
9 <u>-</u> 0 <u>-</u>							T.				
					- 		Ţ				
<sup>2</sup> -3							T				
4					-		Ţ				
5							T				
7					-		۔ ۱ سبب				
8											
					-		Γ				
DRILLING CC	).: <u>Parrs</u>	tt - w	poltt		BAKER REP.: J.E.	Zimmerman					
DRILLER:	<u>6. (a</u>	nsing			BORING NO.: <u>MW3</u>	<u>545B</u> si	ieet 30f				



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#### TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT:	-	Treata	6.1.it.	Stud	y In	-situ 1	lir Spa	<u>rđịn</u>	g Plur	ne B		
CTO NO.:	-	323					BORING			MW354	6 A	
COORDINAT						<u></u>	NORTH:					
ELEVATION	: 3	SURFACI	Ľ:				TOP OF	PVCC	CASING:	<u> </u>		
<b>RIG:</b> # 82	-						DATE		OGRESS	WEATHER	WATE	
		SPLIT SPOON	CASIN	G AU	GERS	CORE BARREL			(FT.)		(FT.)	
SIZE (DIAM	1.)	1-3/8"		6	14'		7-9-96	50	-12.5	partly cloudy, humid (70's)	.5	
LENGTH		2.0			, '		1					
TYPE		Std.			SA		1					
HAMMER V	VT.	140 lbs.					1					
FALL		30"						1	<u>.</u>			
STICK UP							1	-			1	
REMARKS:	Nua	+ 6.010	080	(bas	) Sav	2 6010A	1200 3		0.51 0	1 Changes		
		i bac										
	_	SAMPLE	TYPE			We		Diam.	Туре		Тор	Bottom
	plit Sp			A = A		Inform	ation				Depth	Depth
	helby			W = W				L.			(ft.)	(ft.)
	Air Rota Denisor	1		C = Co P = Pis		Ris	er	2.0"	Schedule PVC		+3.01	-2.0'
		N = No S	ample			Scre	en	2.0"	Schedule 0.01 Slo		-2.01	-12.0'
Depth	Samp	. Samp.	SPT	Lab	PID					Well		
(ft.)	Туре		or	ID	(ppm		Visual D	escrip	tion	Installat		Elevation
	and		RQD	No.						Detai		(ft. MSL)
	No.	%)									<del></del>	=
										開聞	¥	
									-		Benton	ite
2											pelle	S
2					1				-		2" pvc	
3											riser	
					1.4							
4					1.4		. 1	<u> </u>	(1)- oc)		1	
	11-N	-	-			Flu	ger to	<i>8.</i> C	) (ogs)-			
5							1				sand T	
									-		back-	
6												
	1			ł					-			
7									-			
							1				wall_	
8 8.0							Y.		-		screen	
		1 2.0	Not			PENT	MATER	AL W	1		_	
9	5-	1 2.0			.4	deco.	mposed	i wo	bus and			
			24"		.4	-   ROOT	TED M	INTE	RIAL		-	
10 10.0		40%	<u>.</u>			DK.			14 1005	1:2 22		
	A-N	1 -			.4/.2	t use	· <b>· ·</b>	Mate	h to Sheet	2		
DRILLING	<u> </u>	Burg	<u>att-U</u>	50161	<b>P</b>		BAKER	RED	• <b>T</b> .F	Zimmarm	.010	
DRILLER:		G. La	nsima -				BORIN	G NO.	: riu	3546A	SH	EET 1 OF



G. Lansing

DRILLER:

## TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: CTO NO .:

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Treatability Study In-situ Air Sparging Plume B 323 BORING NO .: MW3546M

BORING NO .: MW3546A SHEET 2 OF

DEFINITIONS         SAMPLE TYPE         S = Split Spoon       A = Auger         T = Shelby Tube       W = Wash         R = Air Rotary       C = Core         D = Denison       P = Piston         Depth       Samp.         (ft.)       Samp.         (ft.)       Samp.         (ft.)       Type         (ft.)       Solution         (ft.)			e.	MDIE	TVDE			DEDINI		
T = Shelby TubeW = WashRQD = Rock Quality Designation (%)R = Atr RotaryP = PistonPD = Photoinization DetectorDephSamp.Samp.STLabDephSamp.STLabPID $(th.)$ TypeRec.orInstillation $(th.)$ TypeRec.orInstillation $(th.)$ TypeRec.orInstillation $(th.)$ $TypeRec.orInstillation(th.)TypeRec.orInstillation(th.)TypeRec.orInstillation(th.)TypeRec.orInstillation(th.)TypeRec.oror(th.)TypeRec.oror(th.)TypeRec.oror(th.)TypeRec.oror(th.)TypeRec.oror(th.)TypeRec.oror(th.)TypeRec.oror(th.)TypeRec.oror(th.)TypeTypeTypeor(th.)TypeTypeTypeType(th.)TypeTypeTypeType(th.)TypeTypeTypeType(th.)TypeTypeTypeType(th.)TypeTypeTypeType(th.)TypeType$		S = 2			1116	Δ = Δ.	IGAT			
R = Air Rotary D = DenisonC = Core P = PistonPTD = Photoionization Detector ppm = parts per millionDepthSamp. TypeSamp. or RQDI Lab or No.PID (pm)Visual DescriptionI Installation Installation Detail11 $5 \cdot 2$ $7 \cdot$ Zo $24 \cdot$ $4 \cdot$ Z4Continued from Sheet I Soluto, Sing graved I soluto to brown, JGCY losser ScreavSoluto Continued from Sheet I Soluto, Sing graved I Soluto, Sing grave	1						0			\$(0.5')
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	}								0)	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $										T
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$		~ .		I = No Sa	mple	13	LU11	hhm - hmm her munion		1_
(ft.)Type and NO.Rec. RQD NO.OID NO.(ppm)Visual DescriptionInstallation Installation DetailElevation (ft. MSL; No.11 $S \cdot 2$ $\frac{2}{2}$ $\frac{1}{2}$ $\frac{4}{24}$ $\frac{4}{4}$ South of the second of		Depth	the second s			Lab	PID		I	
and     (ft. & RQD     No.     Visual Description     Installation       11     5.2     20     24     4       12     20     24     4       13     -     35.%       14     -     4/4       15     -       16     -       17     -       18     -       19     -       20     -       21     -       22     -       23     -       24     -       25     -       26     -       27     -       28     -       29     -		(ft.)	Туре	Rec.	or	ID	(ppm)	Vinal Description		Elevation
No. $\frac{5}{20}$ $\frac{1}{24}$ $\frac{1}{4}$ Continued from Sheet 1       Seand 2         11 $5-2$ $20$ $24'$ $\frac{4}{14}$ Senso, Cing grained display to solar to brown, very to brown, very to solar to brown, very to solar to brown, very to brown, ve					RQD	No.		visual Description		
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$			No.	%)					Detail	•
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$		-		.7⁄	WOH				Sand	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	111		5-7	20	1			SAND, time grained	pack	l
13		-			24		4	witrace sitt. OK. brown	No Well	
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	12			22 (3			4.11	to brown, very loose,	Serce	n 🖷
14     <	112	_12.5	<u>FI-75</u>				. 7/.4	<ul> <li>Month is an and the set of the</li></ul>	<b>₩</b> _ <u></u>	
14	15							End of Boring -		
15	14	-								
	14							TD: 12.5' (bas) -	Prog	
16	15	-								L
	1									
	16	-						-		
18										L
18	17							-		_
19										<b>—</b>
20	18									1
20										
	19							_		
	1									[
	20									
		_		1						<b>نېپە</b>
23	21			•						
23		-						_		• .
	22									
		-						_		
	23				J					_ <b>I</b>
	1.4	-						_		_
	24							_		Т
	25		1					-		l
	25									
	26		1					-		<b>—</b>
	1-0			1				—		l.
	27							-		
								-		
	28									ł
								·		-
	29									<b>unș</b>
		11						—		
DRILLING CO.: Parratt-wolff BAKER REP.: J.E. Zummerman	30									I
DKILLING CO.: MARTALE-WOOLLE BAKER REP.: J.E. ZIMMERMAN	000		<u> </u>							
	DKI	LLING C	U.: <u>-</u> Y	76225	2-123	0177		BAKER REP.: <u>J.E. 2</u>	immerman_	



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#### TEST BORING AND WELL CONSTRUCTION RECORD

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PROJECT:	T	reatab	ility_	Study	In-	situ A	ir Spa	vipna	19 PIL	sma	<u> </u>		
CTO NO.:									د.	<u>M</u>	<u>w354</u>	68	
COORDINAT		AST:		<u>.</u>	. <u> </u>		NORTH		a. an 10	<u></u>			
ELEVATION	: S	URFACE	:				TOP OF	PVC	CASING:				<u> </u>
RIG:						<b> </b>						WATE	2
		<u> </u>					DATE		OGRESS	WEATHER		DEPTH	
		SPLIT SPOON	CASIN	G AU	GERS	CORE BARREL			(FT.)			(FT.)	
SIZE (DIAM		1-3/8"		+	Y <u>4</u> "		7-9-9		-32.0	part	14 cloudy	.5	
LENGTH		2.0		5	<u>/</u>		<u>'-'-'</u>	<u> </u>		1100.000			
TYPE		Std.			sa								
HAMMER V	VT.	140 lbs.							<u></u>				
FALL		30"											
STICK UP				<u>.                                     </u>							Jack	1	
REMARKS:	Rora	kale r Kgrou	und i	nuou s.s.	ery 2	awaple		993	αιο το	921	activ	1. MNJ	~
		AMPLE				We	11	Diam.	Туре			Тор	Bottom
1 .	plit Spo			A = Au	-	Inform	ation					Depth	Depth
	helby T .ir Rota			W = W C = Cc					Schedule	- 40		(ft.)	(ft.)
	)enison			P = Pis		Ris	er	2.0"	PVC	. 40		+3.0	- 26.0
		N = No Sa	mple			Scre	en	2.0"	Schedul			-26.0	-31.0
Death	C	1 Comm	SPT	Lab	PID				0.01 Slo	t 		<u>'</u> r	,
Depth (ft.)	Samp. Type	Samp. Rec.	or	ID	(ppm)		\/:1T	<b>`</b> ~~~~!~	tia-		Well Installati		Elevation
	and	(ft. &	RQD	No.			Visual I	Jescrip	uon	1	Detail		(ft. MSL)
	No.	%)								$\frac{1}{1}$			
1 -1.0	A-N	-	-		1.5/s							×	
		.4							-				
2	5-1	2.0	WOH		·5/.5	PER	T MIAT	FRIE	AL WI-	+		grout	.t
	۱ - د	20%	24		1.2	deca			0000	-1-1	-	<sup>3</sup> –	
3 3.0		5				and	ROO	TEOI	MATERIA	t ]	1		
4		.5/20	WOH		.5/	Dar	k bro	ww.	very_			_	
	5-2	1	1 /4		.5	100	ser u	set	(-				
5 5.0		25%							-	+	$\square$	]	
		1.5/2.0			6,					+1		Z" PVC	
6	5-3	2.0	WOH		1.5/				-	-		riser	
7 - 0.0		25%	24						_				
		.3,	-							$\square$		_	
8	5-4	.3/2.0	WOH		1.5				-	-1			
	· ·	15%	1 2 1		1.5					-	-	-	
9 9,0		6			-					+	H		
10	5-5	1/2.0	WOH		1.5				-				
	J-1	30%	24		<u> </u>			Mat	ch to Sheet	2			
				120			DAVD	R REP	. T.F	2.	nmety	AD 14	
DRILLING (				131		<u> </u>							
DRILLER:	-	G. Lan	Sing			···	ROKII	NG NO	.: <u>MW</u>	524	100	SH	EET 1 OF

Baker Baker Environmental, Me

#### TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: CTO NO.:

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Treatability Study In-situ Air Sparging Plume B 323 BORING NO.: MW3546B

_	SA	MPLE	ГҮРЕ			DEFINIT	TIONS	and the second
S = S	plit Spoo		~~~~~	A = Au	ger	SPT = Standard Penetration Test (A	STM D-1586)(Blow	s/0.5')
	helby Tu			<b>W</b> = W	-	RQD = Rock Quality Designation (%	6)	
	ir Rotary			C = Co	ге	PID = Photoionization Detector		
	Denison			$\mathbf{P} = \mathbf{Pis}$	ton	ppm = parts per million		
	N	= No Sa					an in a star a construction of the start of the	۹ 
Depth	Samp.	Samp.	SPT	Lab	PID		Well	
(ft.)	Туре	Rec.	ог	ID	(ppm)	Visual Description	Installation	Elevation T (ft. MSL)
	and	(ft. &	RQD	No.		-	Detail	
	No.	%)	Woll			Continued from Sheet 1		
11	5-5	30%	24		1.5/.5	SAND, fine grained _		
··· - <u>/////////////////////////////////</u>						witroce sitt, little		hant !
12		.4	Woot		.5/	wood splinters Dark brown to brown,	97	out
12	5-6	2.0	24-"		.5			
13 _13.0		20%	24			very loose, wet		1
		.6,	WOH			SAND, fine grained -		
14	< 7	20	6		.5/	wittroce site. Brown		
	5-7				.5	to gray, vary loose, _		
15 15.0		30%	i			usa.t.		
		.9/2.0	1			Siguo, fine to medium grained, trace site, commented		
16	~ 0	-2.0	3		.5/	shell material trace shell		
	5-8				1.5	Fragments. Brown yellowish	-	•
17		45%	18			brown 19toy ( while, med int danse, wet.		-
	:	1.4	17		4	FOSSILIFEROUS LIMESTONE trace little SAND, fine -		Γ
18	5.9	2.0	٩		.5/	grained, trace sitt, little -		
	1	7.01	10		1 1.5	Share material, micrite (motrix) Gray //.ghtgray/white, wet	I IIser	
1919.0		70%	21			SAND, fine to medium	- 14	
		1.8	15		6	grained withere sin -	F F] -	
20	5-10	2.0	15		.5/5	I trace chall matched		
		90%			1 4.5	Light greenish gray/white dense, wat	- 17	
21 <u>210</u>			20			SAND, fine grained WI		ntonite
22		1.0	27		.5/	trace site, little cementer		pellets
<sup>22</sup> —	5-11	2.0	22		1/5	Sandstone nodules, trace		
23 23.0		50%			1	Shell frequents. Light - greenish grovi white, wet		
		2.0	17					1
24		2.0	17		.5,	SAND, fine grained w1- trace silt, trace shell	調 闘	
	5-12	2.0	16		1.5	material. Light greanist		]
25 25.0		100%	18		1	Gray light gray, med. dense		2
		<u>v</u> ,v v v	14			FOSSILIFEROUS LIMESTONE		
26	C 13	20	16		.5	WISAND, fine grained		I T
	5-13				.5/.5	trace sitt, little sherr	Sand	
27 270		100%				material, cemented	Paci	¶
		1.3	25			Shall frogments light		L T
28	5-14-	2.0	17		.5	gray and white, dense		teen _
	1 .	0.04			1 .5			
29 <u>29.</u> 0	1	90%				SAND, fine grained _	修日刻 -	┤
	5-15	2.0	7		1.5/5	witrace silt, trace _ clay, trace shell		1 I.
30	<u> </u>	1.50	6	I		1	<u>- [%/2]</u>	<u>ــــــــــــــــــــــــــــــــــــ</u>
DRILLING (	$ro \cdot F$	breat	4-1.	)olff		BAKER REP.: J.E.	Zimmerman	
		<u>~1111</u>	· ~	<u>a 161 ( 1</u>				
DRILLER:	5	G. (an	sina			BORING NO .: MW	3546 <u>B</u> s	HEET 2 OF
	<b>b</b>							



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## TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT:	Treatability	Study	In-situ	Air Sparging	Plume E	
CTO NO.:	323			BORING NO.:	MW3546B	
COORDINATES:	EAST:			NORTH:		
ELEVATION:	SURFACE:			TOP OF PVC CASI	NG:	

and the second s

RIG:					CODE	DAT	Е		)GRESS FT.)	WEAT	THER	WATER DEPTH	TIME
	SPLIT SPOON	CASING	AUC	FERS	CORE BARREL						<b>6</b> 12	(FT.)	
SIZE (DIAM.)	1-3/8"		6)	<b>'</b> 4"		7-9-9	76	0	-32,0	partly humidi	(90'5)	.5	
LENGTH	2.0		S	'		<u> </u>							- <u> </u>
TYPE	Std.		મ૬	A		<u> </u>							
HAMMER WT.	140 lbs.												
FALL	30"												
STICK UP						<u> </u>							
REMARKS: Bor bo	ckgrou	contiv	10.04° 5.56	ily pm						<i>dz)</i> q	lepth		
	SAMPLE				We		Dia	am.	Туре			Тор	Bottom
S = Split S	•		A = Au	-	Inform	ation						Depth (ft.)	Depth (ft.)
T = Shelby R = Air Ro			$W = W_{2}$ C = Cor			· ·	<u> </u>		Schedule	40		()	()
R = Air RC D = Denise	•		P = Pist		Ris	er	2.	.0"	PVC	40		+3.0	-26.0
	N = No S	ample			Scre	een	2.	.0"	Schedule 0.01 Slot			-26.0	-31.0
Depth Sam (ft.) Ty an No	pe Rec. d (ft. &	SPT or RQD	Lab ID No.	PID (ppm	1	Visual	Des	cripti	ion	I	Well nstallati Detail	on	Elevation (ft. MSL)
1 A 2 5- 33.0	1 20%	24"		.5/.	PEA dece	swpe	bsa	9 r	- 		-	enert grout	Σ.
4 5- 55.0	25%	24 3	• - · •	.5			ous	<i>~</i> , `	10084_ 				
6 <u>-</u> - 5- 7 <u>-</u> 7.0	25%	24		.5	5				-			2" PVC risar	
8 <u>-</u> 9 <u>-</u> 9.0	15%	1 2/1		.5	5				-			-	
10 _ 5.	.5 2.0 30°/	WOH 24"		.5	5		1	Matc	h to Sheet	2			
DRILLING CO .:	Parrat	t-600	ff			BAK	ER F	REP.:	<u>J.E</u>	. Zim	mern	nan	
DRILLER:	G. Lav		• I			BOR				3540			EET I OF



PROJECT: CTO NO.:

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#### TEST BORING AND WELL CONSTRUCTION RECORD

Treatability Study In-situ Air Sporging Plume B 323 BORING NO .: MW3546B

	SA	MPLET	<b>YPE</b>			DEFINIT		
	plit Spoo			$\mathbf{A} = \mathbf{A}\mathbf{u}$	-	SPT = Standard Penetration Test (AS		s/0.5')
	helby Tu			W = W		RQD = Rock Quality Designation (%	)	
	Air Rotary	/		$\mathbf{C} = \mathbf{Cor}$		PID = Photoionization Detector		T
D = 1	Denison	- No Se	malo	P == Pist	ion	ppm = parts per million		
Depth	Samp.	= No San Samp.	SPT	Lab	PID			
(ft.)	Бапр. Туре	Rec.	ог	ID	(ppm)		Well	Elevation T
()	and	(ft. &	RQD	No.	QP)	Visual Description	Installation Detail	(ft. MSL)
	No.	%)					Detail	
			WOLL		.5/.5	Continued from Sheet 1	77 -	
11	5-5	30%	24		<u>/.5</u>	SAND, fine grained		
		.4/2.0			٢.	withoe sit, little		out !
12	5-6	2.0	WOH		.5/	bood splinters Dark brown to brown,	- 1 <b>4</b> - <del>1</del>	<b>.</b>
4			Z4"		.5	very loose, wet		
13 <u>13.0</u>		20%						1
		.6	WOH		~	SANDO, fine grained -	11 -	_
14	5-7	5.0	(a)		.5/.5	withoca site. Brown		Т
		30%	i		>	togray, very loose, _		
1515.0		30/0		a 1499 million (1990) (1990) (1990)	****	SANDO, Fine to medium		
16		in'o	3		5	grained, trace sit, commented		
	5-8		11		.5/	Fragments. Brown yellowish		1
17 0.0	1	45%				brausnigrave fushite, mad unt dansa. usat.		
		1.4				FOSSILIFEROUS LIMESTONE		
18			179		5/5	trace little SAND, fine T	2" PJG	
	5-9	2.0	19		1.5	grained, trace sitt, little - share material, micrite (matrix)	/ riser	
19		70%	21		-	Gray (Light gray lushita, wat		-
		1.00	15	******		SANDO, fine to medium		
20		2.0	15		.5/	grained withress site -		
	5-10		15		.5/	traco shall material.		
21 71.0		90%	21			Light greenish gray/white densa, wat		. 1
		1.0	20			SAND, five grained WI	Ba	ntonite !
22	5 11	2.0	27		1.5	trace site, little comenter		pellets
	5-11	- 01	22		.5/	Sandstone nodules, trace shall frequents, light -	88 189	
23 _ 23.0		50%	19			Shell frequents, Light - greenish gravi while, wet		l
_		2.0	17			SAND, fine grained w1-		
24	5-12	2.0	17		.5	trace sit, trace shell		
		1	16		1.5	material. Light groowigh Growt light gray, mod. donia	え 🕄 🚽	
2525.0	¥	100%						
~ -		20	14		2	FOSSILIFEROUS LIMESTONE WISAND, fine grained		
26	5-13	2.0	10		.5/	traca silt, little shell	Sand	
27270		100%			1.5	material cemented	paci	l '
27 _ 270	1	1.2	25			shell frogments light	877 <sup>•</sup> •	-
28		1.0			.5.	gray and white, dense	Wa wa	LL I
~ –	S-14-	2.0	18		1/2	uset		teen '
2929.c		90%	12			SAND, fine grained		
		2.0	7		.51	withace sitt, trace		I T
30	5-15	2.0			1.5/.5	clay, trace shell		
		Anna an this are similar		•		•		
	$a$ $\overline{D}$	henal	L 1	191 SF		BAKER REP.: $\overline{J. E.}$	Zimmerman	
ORILLING (	CO.: <u></u>	TULUT	$\tau - \mu$	10111				<u>`</u>
ORILLING		<u>arrat</u>						HEET 2 OF



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# TEST BORING AND WELL CONSTRUCTION RECORD

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PROJECT: CTO NO.:		323				<u>BORING NO.:</u>	MW354-6B				
T = Sh	lit Spoo elby Tu ir Rotar enison	ibe y		A = Au $W = W$ $C = Co$ $P = Pis$	ash re	DEFINITIONS SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5') RQD = Rock Quality Designation (%) PID = Photoionization Detector ppm = parts per million					
Depth (ft.)	Samp. Type and No.	= No Sa Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)			
$\begin{array}{c} 31 & -310 \\ 32 & -320 \\ 33 & -320 \\ 33 & -320 \\ 33 & -320 \\ 34 & -320 \\ 34 & -320 \\ 35 & -10 \\ 7 & -10 \\ 8 & -10 \\ 9 & -10 \\ 1 & -10 \\ 9 & -10 \\ 1 & $	5-15 2				·5/.5	Continued from Sheet 2 fragments   shall material, trace fossiliferens s limestore micrite (as matrix), light - gray   white   greenish gray, wet End of Boring - TD: 32.0' (bgs) - - - - - - - - - - - - - -	Sond Pack Welt Seren Welt Plug	2.00			
0				l	1	BAKER REP.: <u>J. E.</u>	Zimmerman				
DRILLER:		. Lans				BORING NO.:					

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### TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT:	Treat ability Study	<u>In-situ Air Sparging</u>	Plume B	
CTO NO.:	323	BORING NO.:	MW3547A	
COORDINATES: ELEVATION:	EAST:	NORTH: TOP OF PVC CASING:		

rig: # 82		•	•				DAT	E		GRESS	WEATHER	WATER DEPTH	
		SPLIT SPOON	CASIN	G AU	GERS	CORE BARREL				FT.)		(FT.)	
SIZE (DIAM	ſ.)	1-3/8"		ى	74"		7-9-	96	0	-12.5	ovarcast, tain shower	.5	
LENGTH		2.0		<									
TYPE		Std.		1-	ISA								
HAMMER V	VT.	140 lbs.				and address to the second second				71444 (1) 1 4 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	<u></u>		
FALL		30"										<u> </u>	
STICK UP						-							
REMARKS:	NO	ered splits	to 17	2.5' ( 50v	<u>vbles</u> pdz)	were	COL	r b rec	sac	<u>d</u>	nd is .sp	sbrv	
		AMPLE	TYPE			We		Dia	ım.	Туре		Тор	Bottor
	plit Spo			A = A	-	Inform	ation					Depth	Depth
	helby T .ir Rota			W = W C = Cc						Schedule	40	(ft.)	(ft.)
	enison	-	omole	P = Pi		Rise	er	2.0	0"	PVC		+ 3.0	-2.0
			-	,	•	Scre	en	2.0	0"	Schedule 0.01 Slot		-2.0	-12.0
Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm		Visual	Desc	ripti	on	Well Installati Detail	ion f	Elevation ft. MSL)
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	К-N				5/5	Aug	jer ti					Jentoni Pertete 2" PVC riser_ Sand pock_ Jell - .creen	te. 5
ORILLING C	ю.: <u>Т</u>	orrat	t-w	olff			BAKE	ER RI	EP.:	<u> 7.e'</u>	Zimmerm	an	
ORILLER:	2	S. Law	zind _	· · · · · · · · · · · · · · · · · · ·	<u></u>		BORI	NG N	10.:	MW	3547A	Shei	IO I TE

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Baker Environmental, inc

# TEST BORING AND WELL CONSTRUCTION RECORD

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**PROJECT:** CTO NO .:

Treatability Study In-situ Air Sparging Plume B 323 BORING NO .: MW3547A

T = S $R = A$	plit Spoo Shelby Tu Air Rotar Denison	ibe	-	A = Au $W = W$ $C = Co$ $P = Pis$	ash are	<u>DEFINITIONS</u> SPT = Standard Penetration Test (ASTM D-1586)(Blo RQD = Rock Quality Designation (%) PID = Photoionization Detector ppm = parts per million	ws/0.5')
Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Well Visual Description Installation Detail	Elevation (ft. MSL)
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	A-N				5/5	Continued from Sheet 1 Auger to depth V End of Boring TD: 12.5' (bgs) 	
DRILLING		21134	et-10	oiff.		BAKER REP .: J.E. Zimmerman	····
DRILLER:		<u>a. Lav</u>					SHEET 2 OF



#### TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: CTO NO.:	<u>ד</u>	<u>raais</u> 323	bildy	stud	ly In	-situ	<u>A'ır</u> BORIN	Spo IG N	10.:	ing P	M	10 B	ß	
COORDINATE ELEVATION:		AST: URFACE	:				NORTI TOP O		vc c	ASING:				
RIG: #82						<u></u>	DATE		PRC	GRESS	WEATHER		WATER	
		SPLIT POON	CASIN	G AU	GERS	CORE BARREL			(	(FT.)			(FT.)	TIVIE
SIZE (DIAM.) LENGTH		1-3/8" 2.0			/4"		7-10-	26	0-	32.0	sverc humi	est, rain	.5	
TYPE		Std.			5' SA			+						<u> </u>
HAMMER WI	. 1	40 lbs.			<u>21 ·</u>			+						- p
FALL		30"								·····				
STICK UP				<u> </u>										
REMARKS: B	stel Nu	nola s	raiar Pomb	led o	14. 511 19 A.	plann	US D	et:	00 C		<u> </u>	N9 35	0' (bg	s).
S = Spli T = She	t Spoo		TYPE	A = At $W = W$		We Inform		Dia	am.	Туре			Top Depth (ft.)	Bottom Depth (ft.)
R = Air $D = Der$	Rotar ison	у		C = Co P = Pis	ore	Rise	er	2.	0"	Schedule PVC	40		+3.0	-26.0
	N	l = No Sa	umple			Scre	en	2.	0"	Schedule 0.01 Slot			-26.0	-31.0
(ft.) 7	amp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)		Visual 1	Desc	cripti	on		Well Installati Detail	on	Elevation (ft. MSL)
$\begin{array}{c} - \\ 4 \\ - \\ 5 \\ 5 \\ - \\ 6 \\ - \\ 7 \\ - \\ -$	1-N 5-1	· 3/2.0 15%			4 4 4 4 4 4 4	PEAT deco Root Dark Wot	MATE ED M brow	RI NT NT	AL Wa Va	, Jee			2	
DRILLING CO.					1	.1	DAVD			<u>, , , , , , , , , , , , , , , , , , , </u>			l_	
DRILLING CO. DRILLER:		01121 01121		0177		·	BAKE			MW3		B		ET 1 OF



#### TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: CTO NO .:

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Treatability study In-situ Air Sparging Plume B 323 BORING NO.: MW3547B

SAMPLE TYPE S = Selit Second A = Augus SPT = Standard Panatration Test (ASTM D. 1586)(Player(0.5))												
S = S	plit Spoo		<u></u>	A = Au	ger	SPT = Standard Penetration Test (A		s/0.5')				
	helby Tu			<b>W</b> = W	-	RQD = Rock Quality Designation (%						
	Air Rotar			$\mathbf{C} = \mathbf{Co}$	re	PID = Photoionization Detector						
D = I	Denison			$\mathbf{P} = \mathbf{Pist}$	ton	ppm = parts per million						
	N	= No Sa	mple									
Depth	Samp.	Samp.	SPT	Lab	PID		Well					
(ft.)	Туре	Rec.	or	ID	(ppm)	Visual Description	Installation Elevat					
	and	(ft. &	RQD	No.		· · · · · · · · · · · · · · · · · · ·	Detail	(ft. MSL)				
	No.	%)										
		.6	WOH		.4.	Continued from Sheet 1						
11	5.2	2.0	and the second s		.7	SAND, fine grained	cerne	110 <del>4</del>				
		30%	24"		1.4	we trace sitt, little decomposed wood	910					
12 12.0		2010				splinters. Dork brown	4 30					
						to brown usery hore						
13	f				.4	wert.						
	N	عدده				-						
14	·				-4							
15						-	-     -					
13 -15.0			WOH					ĺ				
16			5		.4,	N0 -		ŀ				
	5-3	NR	G -			RECOVERY _		·				
			ŝ		.4	KCOUCKI -						
17 17.0												
						-						
18	1				.4	-	2" PW	<b>.</b>				
	N				.4	-	IISQ	-				
19					1.4			•				
					ļ							
2020.0	¥		12			SIDNOD Rive arrived						
21		1.7.1.	13		.4,	SAND, five grained withace silt, some						
	S-4-		lii			commented sandstone						
222	1	85%	14		.4	nodules, trace shell						
22						Fragments   shell -		conite				
23	1					material. Light green-	pat	ats				
		ſ			.4,	Ish gray to light gray						
24	N	-	-	1		and white, modium -						
24					1.4	dence, water -	國際一					
25 25.0	J	1				-						
		1.2	<		•	FOSSILIFEROUS LIMESTON	5av	6				
26		1.5	NOIT		.4,	wishwo, fine grained		CK				
20 -	5-5	2.0	1 -		1%	trace silt, little shell						
27 _ 27.0	-	75%	14		1.4	material and computer						
						Shall Granwouts. Light						
28						gray and white,	we we	u l				
					.4.	madium dense, usat						
29	N	-	-		1/1							
			1		1.4							
30 30.0			1			-	181—181					
			<u>.</u>		<u>و د من میں ا</u> م							
DRILLING	co.: F	gerat	$t - \omega$	olff		$\underline{\qquad} BAKER REP.: \underline{J, E}.$	Zimmerman					
	C	10.00				BODING NO. MUNZ	<b>KA78</b>	UEET 1 () 2 3				
DRILLER:	<u> </u>	S. Lan.	<u>siny</u>			$\underline{\qquad} BORING NO.: \underline{MW3}$	<u>35478</u> s	HEET 2 OF 3				



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#### TEST BORING AND WELL CONSTRUCTION RECORD

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PROJECT:	Ţ	Feata 323	bility	Stu	dy II	<u>n-Situ Air Spargi</u> BORINGI	<u>Na P</u>	<u>10me B</u> MW3547B	······································
CTO NO.:						BURING	NO	10000410	
$\begin{tabular}{lllllllllllllllllllllllllllllllllll$					ash re	<u>D</u> SPT = Standard Penetration RQD = Rock Quality Design PID = Photoionization Detect ppm = parts per million	nation (%	STM D-1586)(Blow	s/0.5')
Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description		Well Installation Detail	Elevation (ft. MSL)
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	5-6	1.5/2.0 75%			.44	Continued from Sheet 2 Sharp find granded Sharp material trans End of Borin TO: 32.0'(695)	(4000) 20 200 - 200 -	SP2	
DRILLING	co.: <u>F</u>	gerat	<u>t-w</u>	oiff		BAKER REP.:	J.E.	Zimmerman	
DRILLER:		j. Lan				BORING NO.:	MW3	<u>5478</u> s	HEET 3OF



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PROJECT: CTO NO.: COORDINATI		statat				<u>n-situ</u>	<u>Hix</u> BORING NORTH	9 <b>01</b> 9 3 NO.	<u>P</u>	lume B MW3548	ĥ	· · · · · · · · · · · · · · · · · · ·
ELEVATION:									CASING:			
RIG: ≠82							DATE	PR	OGRESS	WEATHER	WATER DEPTH	
		PLIT POON	CASIN	g Au	GERS	CORE BARREL			(FT.)		(FT.)	
SIZE (DIAM.	) 1	-3/8"		(c	14"		7-10-9	60	-12.5	Cloudy, humid (Bo's)	.5	
LENGTH		2.0		e	5′							
TYPE		Std.			SA							
HAMMER W	T. 1	40 lbs.										
FALL		30"										
STICK UP												
REMARKS:	Auga: No s	rad - split	to 12. 5000	n Sa	ogs) mpla	depth.	HNU COL	. ba	ckgrou cd	ind is .s	ppm	
	<u>S</u> A	MPLE				We Inform	-11	Diam.	Туре		Top Depth	Bottom Depth
	lit Spoc elby Tı			A = A $W = V$	-	mom	ation				(ft.)	(ft.)
R = Ai $D = De$	r Rotar			C = Contractor C = Pinet		Ris	er	2.0"	Schedul PVC	e 40	+3.0	- 2.0
	N	I = No S	ample			Scre	en	2.0"	Schedul 0.01 Slo		-2.0	-12.0
Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PIL (ppn		Visual D	escrip	tion	Well Installati Detail	on	Elevation (ft. MSL)
$ \begin{array}{c} 1 \\ - \\ 2 \\ - \\ 3 \\ - \\ 4 \\ - \\ 5 \\ - \\ \end{array} $											Benton pertet	s

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#82		SPLIT				CORE	DATE PROGRESS (FT.)		WEATHER	DEPTH	TIME	
		SPOON	CASIN	J AU(	GERS	BARREL					(FT.)	
SIZE (DIAN	И.)	1-3/8"		e l	/4"		7-10-96	0-	12.5	Cloudy, humid.	.5	
LENGTH		2.0		5								
TYPE	[	Std.			SIA							
HAMMER	WT.	140 lbs.										
FALL		30"										
STICK UP												
REMARKS	: Aug No	erad - split	to 12. Spoor	.5°(b n Sav	ngs) c mples	s were	HNJU z Colle	bac 20to	ekgrou zd	nd is .s	ppm	
	Split Sp Shelby '		<u>TYPE</u>	A = Au W = W		We Inform		iam.	Туре		Top Depth (ft.)	Botton Depth (ft.)
$\mathbf{R} = \mathbf{A}$	Air Rot Denisor	ary 1		C = Co P = Pis	re	Rise	er 2	2.0"	Schedule PVC	: 40	+3.0	- 2.0
<u> </u>	·	N = No S	-			Scre	en 2	2.0"	Schedule 0.01 Slot		-2.0	-12.5
Depth (ft.)	Samp Type and No.	Rec.	SPT or RQD	Lab ID No.	PID (ppm)		Visual De	script	ion	Well Installati Detail	on	Elevation (ft. MSL
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	A-N	)	-		· 5/ 43	Klug	er to	der	- - - - - - - - - - - - - - - - - - -		pellet "PVC riser 	2
7 8 9 10								Matel	- 		- 	
8 9 10	<u> </u>	Presa		0166					n to Sheet	2	500 <b>e</b> v 	
8 9		Parra G. Lan		0199			<b>Y</b> BAKER BORING	REP.:	J. E.		Screen 	ET I OF



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## TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: CTO NO.:		<u>reat a</u> 323	bility	<u>stu</u>	dy I	<u>b-situ Air Sparging</u> Boring No.:	Plume B MW3548A					
						DEFINITIONS SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5') RQD = Rock Quality Designation (%) PID = Photoionization Detector ppm = parts per million						
Depth Samp. Samp (ft.) Type Rec.		I = No Sa Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description Continued from Sheet 1	Well Installation Detail	Elevation (ft. MSL)				
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	A-N	-			.5, .5	Auger to depth End of Boring TD:12.5'(bgs)	Sand pack Walt Scrag					
23 24 25 26 27 28 29 30 DRILLING C	X0.: F	<b>8</b> .1.3										
DRILLING C		. Lave		11100		BAKER REP.:, E, BORING NO.:3		HEET 2 OF				

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#### Baker Environmental, Inc.

#### TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT:	<u></u>	reatal	oility.	Stud	y In	-situ	Nir S	Spa	<u>. qi</u>	ng Pl	<u>sma</u>	B	00		
CTO NO.:									10.:		MW 35488				
COORDINAT							NORT			ASDIC.					
ELEVATION	: S(	URFACE				<u> </u>	TOPO	of PV		CASING:	<u></u> ,				
RIG:						<u> </u>	<u> </u>						WATE	,	
# 82							DAT	вΙ		GRESS	WE	ATHER	DEPTH		
		SPLIT	CASIN		GERS	CORE			(	(FT.)			(FT.)		
		POON				BARREL	<b> </b>				OVASC	as+.	<u> </u>		
SIZE (DIAM		1-3/8" 2.0			/4"	<u> </u>	7-11-	96	0	- 32.0	light i	ain (70's)	•5	_	
TYPE		Std.		5				$\rightarrow$							
HAMMER V	UT 1	40 lbs.		<u>–  –  –</u> –	SA		<b> </b>	-+							
FALL	<u>•1. 1</u>	40 10s. 30"						$\rightarrow$		·····					
STICK UP								-+							
	Barak	<u> </u>	amol	71 94	5'm	tomais	1		0.01	~ <u>5</u> .0'	and	32.0	' ( ba c	<u></u>	
REMARKS:	HADU	back	grown	id is	.5 96	icerdan.		5. G.J.	***. <b>**</b> 42+ 1		1997 - Y 1 1 100	,	x~j-	2	
	<u>S/</u>	AMPLE				We	11	Dia		Туре			Тор	Bottom	
	olit Spoo			A = Au	-	Inform	ation						Depth	Depth	
	helby Tu			W = W C = Co				ļ			40		(ft.)	(ft.)	
1	ir Rotar )enison	У		P = Pis		Rise	Riser 2.		0"	PVC	Schedule 40 PVC		+3.0	-26.0	
	۲	1 = No Sa	ample			Scre	Screen 2.			2.0" Schedule 40		-26.0		-31.0	
Denth		1 Same	SPT	Lab	PID			L		0.01 Slot			2.0.0	<u>,                                    </u>	
Depth (ft.)	Samp. Type	Samp. Rec.		ID	(ppm)			~	• ,	•		Well		Elevation	
and		(ft. &	RQD	No.			Visual	Desc	cripti	ion		Installati Detail		(ft. MSL)	
	No.	%)			I						<u> </u>				
										-	+1		7	1	
		1						i.							
2				1	.5					-		П	4		
					5	Au	aer t	0	5.0	(bas)					
3	A-N	-	-				J						1		
								1		-			enzy	t	
4					1			į		-			grout		
								1				A CONTRACTOR			
5 5.0								Ý.			$\mathbb{H}$				
		1.0	WOH		6	PEAT	THM ZOG~				H	$\square$	-		
6	5-1	2.0	-		.5/5	Root	reis I	MA	TEN	2100, -	+1	1			
		50%	24			Dark	brond.	NCA	الم الم	CONNY -	$\square$	Η			
77_0						- 5214	(005	ςσ',	n or			12	" PUC		
8													riser		
° −					.5					-	Ľ				
9	A-N	-	-		.5						IJ				
													J		
10 10.0										· · · · -		$\square$			
	5-2	50%	1/12 /2	l	.5/.5			N	Aatcl	n to Sheet	2	$\square$			
	~ ~						D A 1/7		CD -	Τr	7	nmerr			
DRILLING C		_		17100			BAK								
DRILLER:		<u>G. Lar</u>	prize				BORI	NGI	NO.:	MW	354	<u>+8R</u>	SHI	EET I OF 3	



#### TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: <u>Treatabilit</u>	1 Study I	n-situ Air Sparging T BORING NO .: _	Plome B MW354BB
S = Split Spoon T = Shelby Tube R = Air Rotary	A = Auger $W = Wash$ $C = Core$	DEFINIT SPT = Standard Penetration Test (A RQD = Rock Quality Designation (% PID = Photoionization Detector	CIONS STM D-1586)(Blows/0.5')
D = Denison N = No Sample	$\mathbf{P} = Piston$	ppm = parts per million	
Depth (ft.)Samp. TypeSamp. Rec.SPTand No.(ft. & RQD %)	Lab PID ID (ppm) No.	Visual Description	Well Installation Detail (ft. MSL)
11 <u>-</u> 5-2 1.0 1/2 12 <u>120</u> 50% 1/2		Continued from Sheet 1 SFIND, fine grainad with trace Silt, Title de- Composed wood skinler bark brown brown work	cement
13 N	.5		grout -
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	.5	SAND, fine grained - witroce site	
17 60% 6		Brown, loose to very 100se, wet	211 AVIC riser
$\begin{vmatrix} 18 \\ 19 \\ -19 \end{vmatrix} = \begin{vmatrix} N \\ -1 \end{vmatrix} = -$	.5		
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	· <u>\$</u> .5	SAND, five grained witrace silt, some comouted sand- stone nodules, trace	
23N	.5	shere material I shell fragments. Light greenish gray to light gray and white, dense wat	pailats
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	.5	FOSSILIFEROUS LIMESTONE WISAND, fine grained traca silt, little shell material, cemented	
$   \begin{array}{c}     28 \\     29 \\     30 \\     \overline{30.0}   \end{array} $	.5	sheri fraginents. Light gray and white, medium dense, wet	pock 
DRILLING CO.: Parratt-b DRILLER: <u>G. Lansing</u>			<u>5488</u> SHEET 2 OF

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1. 6. 18 1	ker or Environr	e string industria		TI	EST B	ORIN	G AND WELL CONSTRU	JCTION REG	CORD
PROJ CTO	JECT: NO.:	Ţ	icatal 32 <u>3</u>	sility	Stud	y In	- situ Air Sparging F Boring No.: _	<u>10me B</u> MW3548B	
	T = S $R = A$	SAMPLE TYPE       DEFINITIONS         = Split Spoon       A = Auger       SPT = Standard Penetration Test (ASTM D-1586)(Blows/         = Shelby Tube       W = Wash       RQD = Rock Quality Designation (%)         = Air Rotary       C = Core       PID = Photoionization Detector         = Denison       P = Piston       ppm = parts per million							s/0.5')
	epth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
31 32		5-6	1.6 N.0 80%	TBN24		.5/5	Continued from Sheet 2 SAND, fine grained, trace sit, trace day, trace that material, trace foss, lime, wherite, wet	Sand Pack	
33 34		-					End of Boring - 	user plug	
35 6									
7 8							-  		
9 0									
.1 `2			•						-
·3									
:5 :6									-
7 8 9									

DRILLING CO .: Parratt - Wolff G. Lansing

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DRILLER:

BAKER REP .: J.E. Zimmerman

BORING NO.: MW35488 SHEET 30F3



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PROJECT: CTO NO.: COORDINAT		323	bilitic	stud	y In.	<u> </u>	NORTH	G N(	<u>ai</u> 0.:	ng Pl	UMC B MW354	<u>911</u>	
ELEVATION		SURFACE	3:			7 14/0 10 10 10 10 10 10 10 10 10 10 10 10 10			C C	ASING:			
RIG: #82						· · · · ·	DATE	F		GRESS	WEATHER	WATER DEPTH	TIME
		SPLIT SPOON	CASIN	G AU	GERS E	CORE BARREL			(	FT.)		(FT.)	
SIZE (DIAM	[.)	1-3/8"			14"		7-10-9	6	0-	12.5	cloudy, humid (80's)	.5	
LENGTH		2.0					- <u>-</u>						l
TYPE HAMMER V		Std. 140 lbs.			<u>sa</u>								
FALL	<u>v1.</u>	30"											
STICK UP													
	Kauo	larad.	to 8.0	s, cpd	5).50	mpled	f tro.	γn	8.	0 101	2.0' (bgs)	)	
	HNU	i back	grown	d is	·266	v A							
	plit Sp helby '		<u>TYPE</u>	A = Au W = W	0	We Inform		Dia	m.	Туре		Top Depth (ft.)	Bottom Depth (ft.)
R = A	ir Rot Denisor	ary 1		C = Co P = Pis	re	Rise	er	2.0	)"	Schedule PVC	: 40	+3.0	- 2,0
		N = No S	ample			Scre	en	2.0	)"	Schedule		- 2.0	-150
Depth (ft.)	Samp Type and No.	e Rec. (ft. &	SPT or RQD	Lab ID No.	PID (ppm)		Visual I	Desci	ripti	on	Well Installat Detai	ion 1	Elevation ft. MSL)
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$		.5, 2.0 25%	2		· · · · · · · · · · · · · · · · · · ·	PEAT H decon ROOT brow loose	NATERI ~pose	ALTER	1000 1000 1000	Dand L. Dark Very		Z AC partents 2" AC riser 	
	5-7			I	17.5	]		IVI	atch	to Sheet	4 <u>37</u>	L	
DRILLING (		Pariat	t-w	0199	ana da Salatin da Salatin da Salatin da Salatin da	<u></u>	BAKE	R RE	EP.:		Simmern	an	
DRILLER:	-	G. Lan	sina				BORIN	IG N	Ю.:	MW	3549A	SHE	ET 1 OF ·



DRILLER:

G. Lansing

### TEST BORING AND WELL CONSTRUCTION RECORD

Treatability Study In-situ Air Sparging Plume B 323 BORING NO.: MW3549A PROJECT: CTO NO .: SAMPLE TYPE DEFINITIONS S = Split Spoon  $\mathbf{A} = \mathbf{Auger}$ SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5') W = Wash $\mathbf{T} =$  Shelby Tube **RQD** = Rock Quality Designation (%)  $\mathbf{R} = \mathbf{Air Rotary}$  $\mathbf{C} = \mathbf{Core}$ **PID** = Photoionization Detector  $\mathbf{D} = \mathbf{Denison}$  $\mathbf{P} = \mathbf{Piston}$ ppm = parts per million N = No SampleDepth Samp. SPT Lab PID Samp. Well (ft.) Туре Rec. ID (ppm) or Elevation Visual Description Installation (ft. & RQD No. and (ft. MSL) Detail %) No. Continued from Sheet 1 ⁄9، 1 Sand SAND, five grained wi trace sitt, little decom-posed wood splinters -.5/5 11 2.0 2 <u>pack</u> 5-2 2 USatt 45% 12 12.0 bark brown (brown, loose, wet screpn .5/.5 A-N 12.5 13 End of Boring well plug 14 TD: 12.5' (bgs) 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 DRILLING CO .: Parratt - WOISF J.E. Zimmerman BAKER REP .:

BORING NO.:

MW3549A

SHEET 2 OF 2



TO NO.: COORDINATES: LEVATION:	323			Au In		BORIN NORTH	G NO. I:	<u>ریم سمع</u> : CASING:	M	W1419		
RIG: #82						DATE		OGRESS	WI	EATHER	WATER DEPTH	
	SPLIT SPOON	CASIN	G AU	GERS H	CORE BARREL			(FT.)			(FT.)	
SIZE (DIAM.)	1-3/8"		6	'/ <u>A</u> "		7-10-9	<u>ک</u> ک	0.58-0	<100 (8)	dy, humid	.5	
LENGTH	2.0			· · · · ·				<u>.</u>				
TYPE HAMMER WT.	Std. 140 lbs.			<u>sa</u>						<u></u>	· · · · ·	
FALL	30"											
STICK UP												
REMARKS: Ro	taholo.	Sovep	ned o	t 5'	interve	a15 6	atw	cen 5	.0' a	.nd 32	2.0' (be	5).
S = Split S $T = Shelby$	•		A = Au $W = W$	ıger	We Inform		Diam.	Туре			Top Depth (ft.)	Bottom Depth (ft.)
R = Air RoD = Denis	otary on		C = Co P = Pis	re	Rise	er	2.0"	Schedu PVC	le 40		+3.0	~ 26.0
	N = No S	ample			Scre	en	2.0"	Schedu 0.01 Sl			- 26.0	-31.0
Depth Sam (ft.) Ty an No	pe Rec. d (ft. &	SPT or RQD	Lab ID No.	PID (ppm)		Visual I	Descriț	otion		Well Installati Detail	ion	Elevation (ft. MSL)
$ \begin{array}{c} 1 \\ - \\ 2 \\ - \\ 3 \\ - \\ 4 \\ - \\ 5 \\ - \\ 5 \\ - \\ 5 \\ - \\ 5 \\ - \\ - \\ 7 \\ - \\ - \\ - \\ - \\ - \\ - \\ - \\ - \\ - \\ -$	.4	24		in hi hi	PEAT deco ROO Darl	MATER	2IRL ed U MATI	JOOD			diont	nt.
8 9 //-	N -			.5			* ••••			4	2" (NC	



PROJECT: CTO NO.:

4-14-1

Tractability Study In-situ Air Sparging Plume B 323 BORING NO .: MW3549B

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<u> </u>	SA	MPLE	ГҮРЕ			DEFINIT	TIONS	
S = S	plit Spoo			A = Au	ger	SPT = Standard Penetration Test (A		/0.5')
1	helby Tu			W = W		RQD = Rock Quality Designation (%	6)	
1	ir Rotar	y		$\mathbf{C} = \mathbf{Co}$		PID = Photoionization Detector		
$\mathbf{D} = \mathbf{L}$	Denison		mula	$\mathbf{P} = \mathbf{Pist}$	ton	ppm = parts per million		
Depth	Samp.	= No Sa Samp.	SPT	Lab	PID			
(ft.)	Туре	Rec.	or	ID	(ppm)		Well	Elevation
(,	and	(ft. &	RQD	No.	u ,	Visual Description	Installation Detail	(ft. MSL)
	No.	%)					Detail	
		.4.			~	Continued from Sheet 1		
11	5-2	2.0	WOH		.5/	SAND, fine grained wi trace site, little	- cerni	
12 12.0	) L	20%	24"		.2	decomposed wood -	010	
12						spluxters. Dark -		
13						pronon (promovaria-		
	N	_			5.	1000a. uset		
14	17	-			.5			
						_		
15 15.0								
		1.5	1		.5	SAWD, fine grained -		
16	5-3	2.0	i		.5/.5	withaco silt. Brown		
17 - 17.0		ഹ്	1	1	• >	very loose, usat -	z"put	
17 - 17.5		- <u> </u>					riser	
18					c	-		
					.5			
19	N	,			5	_		
						-		
2020.0								
			13		٤.	shot, fine grained wi trace sitt, some		
21	5-4	2.0	12		1.5/	concented sandstone		
22		65%	19			nodulas, trace sher:		
		·		1		fragments   shell		۰Le
23						material. Light green.		conite lats
					.5	ich gray to light gray		
24	N	-	-		.5	and while, medium		
						demsa, wat.		1
25			13			FOSSILIFEROUS LIMESTONE	Sav Pa	
26		1.0	13		.5.	wishup, fine grained.		
	5-5	2.0	12		.5	Hoce site, little shall		
2727.0		80%	15		.,	material, comented	1月1日 1月1日 1月1日 1月1日 1月1日 1月1日 1月1日 1月1日	
		[				Shall frogmants. Light		
28		1			2	gray and white medium		
					15	dense, wet.	No No	
29	N	-	-		1.5		्र रुष	een
					1			
30 300			]		1			
DRILLING	co.: <u> </u>	anal	<u>d - 10</u>	polff		BAKER REP.: J.E.	Zimmerman	l
DRILLER:	6	S. Lan	sina			BORING NO.: MW3	5498 SH	IEET 2 OF 🕃



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PROJECT: CTO NO.:		<u>120t3</u> 323	6114	y Stu	rgh T	BORING	<u>ing</u> P g No.: _	MW35	8 49B	
T = 5 R = 7	Split Spoo Shelby Tu Air Rotar Denison	ube		A = Au $W = W$ $C = Co$ $P = Pis$	ash ore	SPT = Standard Penetration RQD = Rock Quality Des PID = Photoionization De ppm = parts per million	ignation (%	STM D-1	586)(Blow	s/0.5')
Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Descriptic		Instal	ell lation tail	Elevation (ft. MSL)
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	5-6		10 13 15 18		.5/.5	Continued from Sheet SADO, Five grained silt, traca shell traca fossiliarou traca clay micro End of Born TD: 32.0' (695)	trace		$ \begin{array}{c} Sac \\ Sac $	
DRILLING (	co.: <u>F</u>	gerat	t-4	20155	10 C - 1	BAKER REP.:	J.E. Z	imme	rman	
DRILLER:	G	Lans	sing			BORING NO.:	MW3	5498	SH	EET 3 OF



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### TEST BORING AND WELL CONSTRUCTION RECORD

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Baker Environme														
PROJECT:	<u>1</u>	ant at	itity -	Stude	i Iv	- 5:4.6. 1	Air Sp		ine	J Plu	me 8	25501		
CTO NO.:							NORT		J.:		MW	10000	H	
COORDINAT ELEVATION:		JRFACE:							СС	ASING:				
											r			·
RIG:									ຠຉ	GRESS			WATER	
#82		PLIT	·····	1		CORE	DAT.	E		FT.)	WEA'	THER	DEPTH	TIME
		POON	CASINC	AUC	GERS	BARREL			``				(FT.)	
SIZE (DIAM	.) 1	-3/8"		6	14"		7-11-9	16	0 -	-12.5	overca rain (	5+, 70'5)	.5	
LENGTH	-	2.0		5							,		_	
ТҮРЕ		Std.			50		1							
HAMMER W	VT. 14	40 lbs.												
FALL		30"												
STICK UP														
REMARKS:	Auge	red t	iarou	s' cho	is). :	Sampl Gppm	eq t	LON		3.0 to	2150	169	5)	
		MPLE					ell	Diar	<b>m</b> .	Туре			Тор	Bottom
S = Sp	olit Spoc			A = Au		Inform	nation			••			Depth	Depth
	helby Tu			W = W									(ft.)	(ft.)
	ir Rotar enison	У		C = CorP = Pist		Ri	ser	2.0	14	Schedule PVC	e 40		+3.0	-2.0
	N	I = No Sa	mple			Scr	een	2.0	)"	Schedul			-2.0	-12.0
Depth	Samp.	Samp.	SPT	Lab	PID					0.01 Slo	ι 			1,2,0
(ft.)	Туре	Rec.	or	ID	(ррп	1)	Visual	Descr	rinti	on	1	Well nstallati	011	Elevation
	and	(ft. &	RQD	No.			1 LDuux	2000	- <b>P</b>			Detail		(ft. MSL)
	No.	%)			<b> </b>					· • • • • • • • • • • • • • • • • • • •			7	
												T H	3entari	
											- 🕅 🗸		percet	5
2										-	- 21-			
											-		2" PVC	
3										-	- 2		riser	
	<b>A</b> 1				.6		jer to	່ວຼ		(Loc)	一刻二		-	
4	A-N	-	-		1.0	o Hu	yer to	0.0	່	(0ys) =	-31-			
5								l		_				
								1		_			Sand	
6										-			pack	
7										-			Jell _	
											-81		screen	
8 _ 8.0		9,				PEAT	MAT	ERIA	L.	NI little			-	
9	<i>.</i>	.2.0	WOH		.6		mposo	v b s	Nor	on and				
	5-1				.6	KOO	TED N			AL. 100' 47.				
1010.0		45%				50					-3-	- 2.5		
	5-2	85%	WOH		.4/.	6		M	latcl	1 to Sheet	2 🦄 🗌			

DRILLING CO.: Parratt-Wolff G. Lansing DRILLER:

BAKER REP .: J. E. Zimmerman BORING NO.: <u>MW3550A</u> SHEET 1 OF 2



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Baker Environ	mental, Inc.							
PROJECT: CTO NO.:	T	reat a 323	6:1:+4	Stud	ly In.	-situ Air Sporgling Pli BORING NO .:	DMC B MW3550A	
T = S $R = A$	Split Spoo Shelby Tu Air Rotar Denison	ıbe	<b>`</b>	A = Au $W = W$ $C = Co$ $P = Pis$	ash ore	DEFINI SPT = Standard Penetration Test (A RQD = Rock Quality Designation ( PID = Photoionization Detector ppm = parts per million	STM D-1586)(Blow	's/0.5')
Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$		1.7, 2.0 85%	39 <sup>4</sup> 24"		. 6/19	Continued from Sheet 1 SAND, five grained w( trace silt and decom- Posed wood splitters- Dark brown (versilonse, versilonse, versilons	wet	
29 30								T
DRILLING C	:0.: <u>P</u>	rrat	t-10	01ff		BAKER REP.: J. E. Z	limmerman	
ORILLER:	G.	Lans	ing			BORING NO.: MW3	<u>5501 sh</u>	IEET 2 OF



<u>/---</u> : .

PROJECT:	-	- Troata	bility	Stuc	J. IV	- Situ 1	Air S	109	ain	na pli	sme	В		
CTO NO.:	-	323					BORIN	GN	<b>0</b> .:		MW3	5501	3	
COORDINA	-	EAST:					NORTH	H:						
ELEVATION	I: :	SURFAC	E:				TOP O	FPV	C C	ASING:	<u> </u>			
RIG:								Τ					WATE	2
#82							DAT	E   1		OGRESS	WEAT	HER	DEPTH	
		SPLIT SPOON	CASIN	g au	GERS	CORE BARREL			(	(FT.)			(FT.)	
SIZE (DIAM	1.)	1-3/8"		6	1/4"		7-11-9	6	0	- 32.0	primig	t (80'5)	.5	
LENGTH		2.0			5'									
TYPE		Std.		<u> </u>	ISA	<u></u>	<u> </u>							
HAMMER	WT.	140 lbs. 30"											*	
FALL STICK UP		30**												
		1 1	<u> </u>	<u> </u>	- 1 1 10	()), 1 0 0)	1010		L		5010	und T	2201	
REMARKS	: Rou	chole u bac	Kgroup 20mp	nag (	at s is.A	- ppm.	0912	Da.	tu	seen	212 0	Drv.	5210	(032).
	4	SAMPLE	TYPE	- <u></u>		We		Dia	m.	Туре			Тор	Bottom
	plit Sp			A = Au	•	Inform	ation						Depth	Depth
	helby i Air Rota			W = W C = Cc						Schedule	40		(ft.)	(ft.)
	Denisor	1		P = Pis		Ris	er	2.0	)"	PVC			+3.0	-26.0
		N = No S	Sample			Scre	en	2.0	)"	Schedule 0.01 Slot			-26.0	-31.0
Depth	Samp	. Samp	SPT	Lab	PID							Well		
(ft.)	Туре			ID	(ppm	)	Visual I	Desc	ripti	ion	Ir	stallatio	on	Elevation
	and No.	(ft. & %)	RQD	No.		1			•			Detail		(ft. MSL)
											ЬT	15	;	
										_				
		1								-		1	4	
2								,			$\left  \right $			
	H-N	1 -	-		.4	Aug	er to	১ 5	.0'	(bgs).	$\left\{ 1 \right\}$			
3		~			1.4					<u> </u>			enter	nt
								-		-			grout	
4												K	~ –	
5 _ 5.0							١	1		•				
		.4	-			PEAT								
6			Woll		.4		~posa							
	5-1		24		.4		1 6737			•			_	
77_0		20%	<u></u>				a, no		, u	erv -				
												1	-	
8					.4	,						$\int 2$	" PVC	
9	A-N	1 -	-	ļ	4						4		pipa	
					.4									
10 10.0														
	5-2	2 1.1/2.0	D 24"		.4/.4	4		M	latcl	n to Sheet	2			
DRILLING	CO.:	Parra	<u>itt-U</u>	201ff			BAKE	R RI	EP.:	<u> </u>	Zim	narn	<u>ian</u>	
DRILLER:		G. Lau		_			BORI	NG N	10.	MIN	<u>3550F</u>	2	SHI	EET 1 OF



PROJECT: CTO NO.:

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Treatability Study In-situ Air Sparaing Plume. B 323 BORINGNO .: MW3550B

T = S $R = A$	plit Spoc Shelby Tu Air Rotar Denison	ıbe		A = Au $W = W$ $C = Co$ $P = Pis$	ash re	DEFINIT SPT = Standard Penetration Test (A RQD = Rock Quality Designation (% PID = Photoionization Detector ppm = parts per million	STM D-1586)(Blow	s/0.5')
Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation ( (ft. MSL)
11 1212,	5-Z	.9/2.0 45%	W04 24		.4	Continued from Sheet 1 SAND, Fine grained wi trace silt; little decom- pose à Wood splinters - Dark brown to brown-	6 6 1 1	
13 14 1515.0	Ņ		<b>1</b> 2		.4			
16 16 1717.0	5-3	·3/2.0 15%	2 00 m v		.4	SAND, fine to medium grained intrace site comented shell material, trace shell	2"20	Ţ 
18 19	N	-	ł		.4.	fragments. Brown to Yallowith brown and White, medium darso, Wat	riser	
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	S-4	13 N. 5%	11 12 11 16		.4/4	SAND, five grained _ withace sit, little _ commented sandstone- nodules, trace shell _		<b>7</b>
23 24 2525.0	N	-	<b>8</b> .5		.4	fragments [shell - moterial. Light greenish gray to light gray and white, medium dense, wet-		ovita lats
25 <u>25.0</u> 26 <u> </u>	5-5	1.2/2.0	10 17 18		.4	FOSSILIFEROUS LIMESTORIE wishwo, fine grained, trace sill, little shelf material and cement	Pac Pac	k Ţ
28 29 30 <u>30.0</u>	N	-	-		.4	ted shell fragments - Light gray and white dense, wat	wei	
DRILLING ( DRILLER:		Lang		nrf		BAKER REP.: J.E. Z BORING NO.: MW3		HEET 2 OF



**PROJECT:** CTO NO .:

Treatability Study In-situ Air Sparging Plume B 323 BORING NO.: MW33550B

SAMPLE TYPES = Split SpoonA = AugerDEFINITIONST = Shelby TubeW = WashRQD = Rock Quality Designation (%)R = Air RotaryC = CorePID = Photoionization Detector												
								/0.5')				
							<b>(</b> 0)					
		Y										
D = L	Denison	N. C.		$\mathbf{P} = \mathbf{Pis}$	ton	ppm = parts per million						
- Durth		= No Sa		Lab	PID		1 1					
Depth	Samp.	Samp. Rec.	SPT or	ID	(ppm)		Well	Elevation				
(ft.)	Type and	(ft. &	RQD	No.	(Pbu)	Visual Description	Installation	(ft. MSL)				
	No.	(n. œ %)	INQD	110.			Detail					
	140.		1.7			Continued from Sheet 2	Sand					
31		1.3	18		.4	Continued from Sheet 2 SAND, Fine grained with Hace Site, Hace Clay	A Dack					
	5-6	2.0	18		.4	Hace Site Hace Clay						
32 320		65%	12			traca shall mat., trace fors. time., micrite, wet	「「「「「」」					
						End of Boring _	weil					
33							Scrad	10				
						TD: 32.0' (bgs) -		· · ·				
34							N wei					
						_	Pluq	·				
35			Í		ļ			ſ				
						_						
6						l						
						_						
7		ļ										
8												
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9												
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0		1					4					
					1	-	4					
		•										
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2												
		1		l	1	-	-       -					
3							$\left\{ \left  \right\rangle \right\} = \left\{ \left  \right\rangle \right\}$					
	]					-	4       -					
4							$\left\{ \left  \left  \right  \right\rangle \right\}$					
5	[		1	1	[	-		[				
<sup>3</sup> –		1			· ·							
						-						
<sup>16</sup>	1		1				1       -1					
7		1	1			-	1					
' -	1					-	1111 -					
8			1			-	1111 1					
$ $ $\neg$ $\neg$		1	1				1       -1					
						-	1					
$-$							]       -1					
		1	1	1								
DRILLING	0 ] ] ] ] ] ] ] ] ] ] ] ] ] ] ] ] ] ] ]											

DRILLER:

G. Lansing

BORING NO.: MW3550B SHEET 30F3

A stability of the second stability of the second stability of the second stability of the second stability was stability of the second stability o

n provinské kolektri a politik kolektri spolské kristik se kolektri k se svejské kolektri k kolektri k stali s Politik kolektri za kolektri se za střekter se kolektri k kolektri se so so kolektri k kateri k se kolektri stá

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### TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT: CTO NO.:	Treatability study J 323	BORING NO .:		
COORDINATES: ELEVATION:	EAST: SURFACE:	NORTH: TOP OF PVC (	CASING:	

11.08.0

RIG: # 82						DAT	E P		GRESS	WE.	ATHER	WATE	
	SPLIT SPOON	CASIN	G AU	GERS	CORE BARREL			(	FT.)			(FT.)	
SIZE (DIAM.)	1-3/8"		6-	/4 "		8-21-4	16	0-	31.0	Clan 10	r, datas.	≈ 2.0	
LENGTH	2.0		5.	0									
TYPE	Std.		1-1	SA									
HAMMER WT.	140 lbs.												
FALL	30"												
STICK UP													
REMARKS: 14 3	ngered	to 1.0 s), HNI	s' (be	is). C Ckgr	iontinu ound i	s.81	4 5 Ppn	$\omega_{i}$	mpled	£ĸ	ovn 1	0.(Pe	12) fo
	SAMPL				We		Dian		Туре			Тор	Bottom
S = Split	Spoon		A = Au	-	Inform	ation						Depth	
T = Shell	•		W = W									(ft.)	(ft.)
R = Air H	•		C = Cc P = Pis		Rise	er	2.0	"	Schedule	40		+ 3.0	-24.0
D = Deni	son N = No	Sample	P - FIS	lon					PVC Schedule	40		1 - 40 March	
		-			Scre	en	2.0	"	0.01 Slot	40		-24.0	) - 26.c
•	mp. Sam		Lab	PID							Well		
	ype Rec nd (ft. é		ID No.	(ppm	v	Visual 1	Descr	ripti	on		Installat	ion	Elevation (ft. MSL)
	nd (ft. 8 Jo. %)		140.	]							Detail	l I	
	·N -	-		·8/ 8./	3 Aug	er to	60'	6	95) -	1		-	
·		WOH		-	SANO	, fine	gra	ain	ed wi				
2		12"		.8/	trac	a to	son	na	site - terial -			7 7	
	- (	1/12"		8.	Dar	c brow	on t	:0 <sup> </sup>	brown				
3 3.0	90%	6 12				1005				$\square$			
_		NOOH			Sandy				oma nposad-				L
4		6		.8 .8	woo	d Spi	Nt6	ET S	. Brown			Canel	
$   _{\mathcal{I}}$	-2			1 1.8		104,1				$\square$		J	
5 _ 5.0	90%	<u>u</u> 1				tor				$\square$			
		WOH		R I	Sand	~ CLA			(orande] ome				
<sup>6</sup> –   <	-3	ېنې ۱		.8. 8.	brou	. 07.00 201) Si	tain		g. Gray.	$\square$			
- 1	30	% 2			Var	( LOOS	a to	20	rui eott	$\square$		-	
7					moi CLOY		4110	<	ilt, trace				
		27		.8					ned.		1	-	
8 - 5	4	23		.8	1 38.9.	ation						2" 940	
9 9.0	30	1			Genau	1 200 - 24 1 200 - 24	લ્લાપ્ય ક≓્ર્	· · · (	]. Gray-			riser	
					CIL			ادر	trace.				
10 _ <	-5 2.0	) WOH		.8.	104	, ttla	Sar	vg	, fine				
	70%				, dia	ined	· Ma	atch	to Sheet 2	2			
			<u>.</u> .			DAVE	ים ח	- -	т <i>г</i>	7			
DRILLING CO.	Parte	W- 571	UITT			BAKE	K KE	.r.:	<u> </u>	Lin	marn	an	

DRILLER:

R. Bush

BORING NO.: MW35518 SHEET 1 OF 3



Treat ability Study In-Situ Air Sparning Plume C PROJECT: 272 CTO NO .: BORING NO .: MW3551B SAMPLE TYPE DEFINITIONS S = Split SpoonSPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5') A = AugerT =Shelby Tube W = WashRQD = Rock Quality Designation (%) C = CoreR = Air Rotary**PID** = Photoionization Detector  $\mathbf{D} = \mathbf{Denison}$ ppm = parts per million  $\mathbf{P} = Piston$ N = No SampleDepth Samp. SPT Lab PID Samp. Well ID (ft.) Type Rec. or (ppm) Elevation Visual Description Installation (ft. & RQD and No. (ft. MS<sup>\*</sup> Detail No. %) 8.8 Continued from Sheet 1 1 3 5-5 70% 11 11.0 Oxidation (orange) 3 can 0.1 an brown) standing. Gray .8/8/ N CN (N ut. 12 2.0 949 5-6 to brown, soft to 10050, maist 50% 13.0 13 CLAY wisht and trace sand, fine grained. Dark greenish gray, -1.3 WOH ·8/ 8. 14 20 12" 5-7 2 soft (plastic) moist. 60% 15 15.0 1.4 WOH .8, 16 2.0 CLAY WISILE. Dark 5-8 24 <u>.</u>8 ZUTAUC greenish gray to very 70% risdr 17 17.0 dark gray, vary soft 1.5 1 (plastic) moist .8 .8 18 ł 20 5-9 ş 75% 19 19.0 SAND, five grained 1.1 MOCN witrace silt. Dark 2.0 Bent 20 ·8/8 12" counte 5-10 gray, very loose, wet pathats 12 55% 21 21.0 1.1 WOH SAND, fine to medium . 8, 22 2.0 12" grained, trace silt. Gray to brown, vary 5-11 .8 • 55% 23 Z3.a loosa, wat. SAND, fine to medium 6 1.9 sawld grained, trace silt, padk 10 24 2.0 .8/8 cementad shells, trace shell frags. Brown/yellow brown/white, med. dense S-12 9 80% 9 25 25.0 wa 08 1.3/2.0 SAND, fine grained, tr. SCREEV silt, little camented .8 .8 26 Sandstone nodules, comented shell mat/frage Light greenish gray/light gray 5-13 12 65% 14 27 27.0 FOSSILIFEROUS LIMESTONE 1.8 14 well SAND, fine grained, tr. ·% 28 18 2.0 plug silt, fr. Comented sheir mat./frags, micrite. Wet 5-14 16 90% 17 sand, fine grained, tr. 29 29.0 silt, tr. camented shell -mat. Ifrags, micrite. light gray/white, wat 12 · 8/8 5-15 90% 30 12 DRILLING CO .: Parratt-Wolff J.E. Zimmerman BAKER REP .: R. Buch DRILLER: BORING NO .: MW3551B

SHEET 2 O



PROJECT: CTO NO.:

1. 11 March 1

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### TEST BORING AND WELL CONSTRUCTION RECORD

Treatability study In-Situ Air Sparging Plume C 323 BORING NO.: MW3551B

<u> </u>		SA	MPLE	<b>TYPE</b>			DEFINIT		
		plit Spoo			A = Au		SPT = Standard Penetration Test (A ROD = Rock Quality Designation (%	STM D-1586)(Blow 6)	/\$/0.5')
		helby Tu ir Rotar			W = W C = Cor		PID = Photoionization Detector	0)	
		Denison	ý		P = Pist		ppm = parts per million		
			= No Sa	mple					
	Depth	Samp.	Samp.	SPT	Lab	PID		Well	Elevation
	(fl.)	Туре	Rec. (ft. &	or RQD	ID No.	(ppm)	Visual Description	Installation	(ft. MSL)
		and No.	(IL & %)	КŲD	140.			Detail	
				ওচ		·8/8	Continued from Sheet 2 SAND, Cine grained, trace site trace clay trace shell mot.	-	
31		5-15	90%	9		1.0	troca clay trace shell mot.	-	{
					2		End of Boring _	-     -	1 1
32							TO: 31.0' (695) -		
33	-1								
							-	-	4
34		-						{	4
35									1
									]
6								4	4 1
	4		Į				-		
7									1
8	-						-		]
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9								4111 -	-
	_						-	111 -	-
0							_		
1	_								4
			1				-	4       .	-
2							_	-     -	-
.3	-1				1		-		
4								4       -	4
	_						-	411.	-
5									1
6	-						-		]
						1	-		4
7		1						-       -	-
							-		-1
8							_		
9							_	]       _	_
								-	-
			<u> </u>						<u></u>
DR	ILLING	CO.:	Parro	<u>++- w</u>	20122	. <u></u>		Zimmerman	
DR	ILLER:		R. Bu	sh			$\underline{\qquad} BORING NO.: \underline{MW};$	3551B	SHEET 3OF 3



PROJECT:	-	- Treata	61:44	Stu	hy In	- Situ	Air	500.0	<u>a</u>	inna F	Nov	na C		
CTO NO .:	_	323					BORIN	IG NO	).:	<u> </u>	Mu	ა <u>3552</u>	A	
COORDINA	TES: I	EAST:					NORT							
ELEVATION	J: 5	SURFACE	E:				TOP O	F PVC	C.	ASING:				
RIG: # 8	2						DAT		RO	GRESS	WE	ATHER	WATE	
		SPLIT SPOON	CASIN	G AU	GERS	CORE BARREL	DAI		()	FT.)	WL.	THER	(FT.)	
SIZE (DIAN	1.)	1-3/8"		Co-	14		8-24-	96 0	0-23.0'		clear, warm (70'5)			
LENGTH		2.0			C									
TYPE		Std.		14	142								<u> </u>	
HAMMER	WT.	140 lbs.											ļ	
FALL STICK UP		30"				<u></u>								
			Calc		Deill				4.0	0 7 2 -	<u> </u>	0 (1) 1)	0 501	
REMARKS	Spor	erto sin Sa	mple	<u>sys)</u> . <u>s_us</u>	ere ca	succes	d. <u>H</u>	ろん	6	ackgr	o ro o ro	$\frac{ds}{d}$ is .	<u>spin</u>	
	S	AMPLE				We	1	Diam		Туре			Тор	Bottom
	plit Spo helby T			A = A $W = W$	•	Inform	ation						Depth (ft.)	Depth (ft.)
	Air Rota			C = Cc				0.01	+	Schedule	40		(10)	· · · ·
D = I	Denison			P = Pis	ston	Rise	r	2.0"		PVC			+3,0	-18.0
	N = No Sample							Screen 2.0"			40		-18.0	-23.0
Depth (ft.)	Samp. Type		SPT or	Lab ID	PID							Well		Elevation
(11.)	and	(ft. &	RQD	No.	(ppm)		Visual I	Descrij	ptic	on		Installati Detail	on	(ft. MSL)
	No.	%)												
										-				Į
										-			_	
2											+1	1	,	
3	A-N				1.5/5	Auge	r to	5.0'	(6	ogs) -			ement	. <b>.</b>
	1-1-103				1.5					_			1	1
4										_				
										_	]			
5 5.0							V	•						
6		1								_				•
											1			T
7										-		2	" PVC	
											Į.	1	iser	
8	N				.5,	Drill .	to 2	3.010	ch	as) -				Γ
		-			·				<b>~</b> ~		$\left  \right $		_	£
9											+	Н		
10										-		1		
							ý.	Mate	ch (	to Sheet 2	I	Ĺ	1	
DRILLING C	O. F	heratt	- 410	155			BAKEI	2 2 2 2		JF	2	merm		
				<u></u>										
DRILLER:	10	. Bush	<u>`</u>				BORIN	ON D		<u>MW3</u>	225		SHE	ET 1 OF 2



PROJECT:

CTO NO.:

11.11

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) } Treatability Study In-Situ Mir Sparging Plume C 323 BORING NO .: MW3552A

r		MPLE '	TYPE			DEFINI	TIONS	
S = S	plit Spoc			A = Au	Iger	SPT = Standard Penetration Test (A		's/0.5')
	helby Tu		-	W = W	•	RQD = Rock Quality Designation (		,
	Air Rotar	у.		$\mathbf{C} = \mathbf{Co}$		PID = Photoionization Detector		
D = I	Denison	I NIA CA		$\mathbf{P} = \mathbf{Pis}$	ton	ppm = parts per million		
Depth	Samp.	I = No Sa Samp.	SPT	Lab	PID	l I	1	
(ft.)	Туре	Rec.	or	D	(ppm)		Well	Elevation
(,	and	(ft. &	RQD	No.		Visual Description	Installation Detail	(ft. MSL)
	No.	%)					Detall	
						Continued from Sheet 1	- Cemer	<b>.</b> +.
							growt	
12							11 -	
					ł		2" PUC	
13							riser	
14						-		
<sup>14</sup>								
15					<b>_</b>	-		onita
	N				.5	Drill to 23.0' (bgs) -	Pett	ats
16							- 関 関	
17						-	- Sand	
						t	pock	
18						1		
						-	- <u>Ki</u> lain -	
19							- 約日刻 —	
20						-	- Juselr	
							scrae	r
21		•						
						-	-	
22								
23						Y -		
						End of Boring -		
24		ļ					- well plug	
25						TD: 23.0' (bgs)		
23							4	
26						-		
27						-	4       -	
28						-	-       -	
						. –	]	
29								
		I	I		L		<u></u>	
DRILLING (	л: <u>н</u>	241.94	2-03	ttlo	<u></u>	BAKER REP.: <u>J. E.</u>	<u>cimmerman</u>	
DRILLER:	R	<u>, Bus</u>	h			BORING NO.: <u></u>	<u>355214</u> 5	HEET 2 OF ;



PROJECT: CTO NO.:	Treatability Study In-Sit 323	<u>u Hir Sparging F</u> BORING NO.:	NW3552B	
COORDINATES: ELEVATION:		NORTH: TOP OF PVC CASING:		
RIG:		<u> </u>		

#8;		SPLIT SPOON	CASIN	G AI	JGERS	CORE BARREL	DAT	E		OGRESS (FT.)	WEATHER	WATER DEPTH (FT.)	
SIZE (DIA)	i	1-3/8"			1⁄4"		8.24.	.94	0	32.0	ciear, warm humid (70'5)		
LENGTH		2.0			5.0		0.24	10	9-		numid(70'2)		
TYPE		Std.			SA SA								
HAMMER	WT	140 lbs.			JH .		<u> </u>			······································		1	
FALL		30"											
STICK UP													
	32.0	sichas	). HN	(695) U ba	). San ckgr	oundi	5.51	vi' Ppi	nter m.	rvals !	from s.o'	cbgs; t	0
		AMPLE	TYPE			Wel		Di	iam.	Туре		Тор	Bottom
	Split Spo			A = A	-	Informa	ation					Depth	Depth
	Shelby T			W = V								(ft.)	(ft.)
	Air Rota Denison	•		C = C P = Pi		Rise	r	2	.0"	Schedule	40	42 ~	
וייע		N = No Sa	ample	r - r1	5(011					PVC		43.0	- 22.0
			ampio			Scree	en	2.	.0"	Schedule 0.01 Slot		-22.0	-27.0
Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm	)	Visual I	Des	cripti	on	Well Installati Detail	on E	Elevation ft. MSL)
$\begin{array}{c} 1 \\ - \\ 2 \\ - \\ 3 \\ - \\ 3 \\ - \\ 4 \\ - \\ 5 \\ - \\ -$	A-N	-			in/n	Auger	to	5.0	s' (I			grout	5
6 7	5-1	.6 2.0 30%	1 1 3		.5/.5	Silt lora is t	. Oxi	dat bri ibli	tiov awv e.G	nistain		2" PVC riser	
8 9	2				.5/5					  			
10 <u>10.0</u>	< >	1 - 91			1.57						НИ		
	5-2	60%			·5/.5	<u> </u>		M	latch	to Sheet 2			
RILLING				oiff			BAKEF			J.E.	Zimmeri	man	
RILLER:	R	. Bust	<u> </u>			l	BORIN	IG N	10.:	MW	3552B	SHEE	T 1 OF 3

### Baker Baker Environmental, re

# TEST BORING AND WELL CONSTRUCTION RECORD

PROJECT:

CTO NO .:

Treatability Study In-Situ Nir Sparoling Plume C 323 BORING NO.: MW35528

		S.	MPLE	TYPE			DEFINITIONS					
		plit Spoc	on		<b>A</b> = Au	-	SPT = Standard Penetration Test (A	STM D-1586)(Blows/0.5')				
		Shelby Tu Air Rotar			W = W C = Co		RQD = Rock Quality Designation (9	%)				
		Denison	У		$\mathbf{P} = \mathbf{Pis}$		PID = Photoionization Detector ppm = parts per million					
		N	l = No Sa				hhm han he man					
Dep		Samp.	Samp.	SPT	Lab	PID		Well				
(ft.		Type and	Rec. (ft. &	or RQD	ID No.	(ppm)	Visual Description	Installation Elevation				
		No.	%)		····			Detail (ft. MSL)				
11	-		1.2	אוטאט		<	Continued from Sheet 1 Silty CLAY witrace Sand					
	]	2-2	0.5	· (^		.5	fine graine d. Oxidation					
12	12.0	·····	60%	1			Grange/brown) stain - is traceable. Gray -					
13 _							soft to medium shift -	cement				
		N				.5						
14	-					5/5						
15	15.0											
16 _		<b>C</b> 0	<u>o) i</u>	3 WOH		5.	CLAY W(Silt. Dark _ greenish gray, very _	2" PVC riser				
	┥	5-3	65%	18"		.5/5	soft (postic), moist _					
17	17.0		9373									
18	+					.5						
19	1	N				·v/··		Bentovite				
20 _	20.0						_	perfects				
21 -	$\left  \right $	-	1.2	1 2		e	SAND, fine to medium					
	1	5-4	2.0	NNN		·5/1.	grained witrace silt Gray to brown, loose,					
22 _	22.0		60%				wat -					
23 _							-	padk				
24	1	N				.5/	_					
25							-	ward				
	25.0		1.6	3			SAND, fine to medium	Screen				
26	$\left\{ \right\}$	5-5	2.0	M4 V1 80		·5/ ·5	grained, trace silt - cemented shall -					
27 _	27.0		80%	8		•	material, trace shelt frogments +					
28 _							SAND fine grained					
_	$\left  \right $	N				.5	trace silt, little cemented sondstone	weit				
29	1	2		1		· ۲	nodules, trace to little comented shell mat.	euld - blog				
30	30.0						Brown/light graenish - gray llight gray, wet					
DRILLI	NG C	0.: <u>R</u>	urrat	<u>t - w</u>	polet		BAKER REP.: <u>J.E.</u>	Zimmerman				
DRILLE	ER:	R	Bust	n			BORING NO.: <u>MW35</u>	5528 SHEET 2 OF 3				



PROJECT: CTO NO.:

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Treatability study In-Situ Air Sparging Plane C 323 BORING NO .: MW3552B

SAMPLE TYPE $S = Split Spoon$ $A = Auger$ $T = Shelby Tube$ $W = Wash$ $R = Air Rotary$ $C = Core$ $D = Denison$ $P = Piston$ $N = No Sample$						DEFINITIONS SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5') RQD = Rock Quality Designation (%) PID = Photoionization Detector ppm = parts per million						
Depth (ft.)	N Samp. Type and No.	= No Sa Samp. Rec. (ft. & %)	mple SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)				
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	5-60	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~			in the second seco	Continued from Sheet 7 SAND, fine grained came utad Shell's (micrite) SAND, Fine grained, fr. Silt fr. clay, fr. Shell mat. Green gray/White, damp Find of Boring TD: 32.0' (695)						
DRILLING (				solft		BAKER REP.: J.E.Z						
DRILLER:	R	. Bus	<u>h</u>			BORING NO.: <u>MW3</u>	<u>5528</u> s	HEET 3OF :				



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PROJECT: CTO NO.:		110018	Dility	Sty	1311 L	n-zitu	HIC S	<u>20010</u>	<del>jung P</del>	NUNZEE	2 10	
COORDINAT	FES I	EAST					NORTI	UNU. I		1100 200	<u>58</u>	
ELEVATION		SURFACI	E:						CASING:			
RIG:											WATE	
#82							DAT	E PR	ROGRESS	WEATHER	DEPTH	
		SPLIT	CASIN		UGERS	CORE		-	(FT.)		(FT.)	
		SPOON				BARREL						
SIZE (DIAM	1.)	1-3/8"		<u> </u>	- 1⁄4"	· · · · · · · · · · · · · · · · · · ·	8-26-	76 C	0-21.0	Partly cloudy mild (60's)		
LENGTH		2.0			5.0							
TYPE		Std.		<u> </u>	ISA		ļ					_
HAMMER V	<i>N</i> T.	140 lbs.						_				
FALL		30"					<b>_</b>					
STICK UP												
REMARKS:	Mug	ered t	6 5.0	(pdz	). Dri	iled fro	and S.C	1669	s) to 2	1.0'(695).	HNU	
ļ				· ppm	. No s	· .		_		collected		
		SAMPLE	<u>TYPE</u>			We		Diam.	Туре		Тор	Bottom
	plit Spa helby 7			A = A $W = Y$		Inform	ation				Depth	Depth
	ir Rota			C = C					Schedul	. 40	(ft.)	(ft.)
	)enison			P = P		Ris	er	2.0"	PVC	8 40	+ 3.0	-15.5
		N = No S	ample						Schedule 40			
						Scre	en	2.0"	0.01 Slo		-15.5	-20.5
Depth	Samp	. Samp.	SPT	Lab	PID					Well	·	_1
(ft.)	Туре		or	ID	(ppm	)	Visual I	Descrin	tion	Installat	ion	Elevation
	and	(ft. &	RQD	No.			, iouur z	, open b		Detai		(ft. MSL)
	No.	%)				_				<u>  </u>		
							;				-	
· -												
2									•		-	
	. /				.4						icmen	÷.
3	N	-			.4	Auge	r to s	) '0.	bgs) .		grout	
						Ĵ	!				~ _	
											-	
											-	
5 _ 5.0							Ý		•		-	
			·				••••••					
6									•			
									****			
7									-		" NC	
					.4						riser	
					.4		1		(			
						Vent	to :	21.0 1	(bgs) -		-	
9									-		1	
							1		-			
10												
			L				ý	Matc	h to Sheet 2			
		D	1. 1				DAVD		TF	7		<b>--</b>
DRILLING C				117.7	· · · · · · · · ·		BAKEF			Zimmer	man	
DRILLER:	7	2. Bus	h				BORIN	G NO.	: MUS	<u>2553A</u>	SHE	ET I OF 2



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Baker Environmental, Inc

PROJECT: <u>Traatability Study In-Situ Air Sparaing Plume C</u> CTO NO.: <u>323</u> BORING NO.: <u>MW3553A</u>

		MPLE'	<b>TYPE</b>			DEFINITIONS				
	plit Spoo		-	$\mathbf{A} = \mathbf{A}\mathbf{u}$	-	SPT = Standard Penetration Test (A		s/0.5')		
	helby Tu			W = W C = Co		RQD = Rock Quality Designation ( PID = Photoionization Detector	%)			
	Air Rotar Denison	y		P = Pis		ppm = parts per million				
		= No Sa	mple	× 115	ton			· = ·		
Depth	Samp.	Samp.	SPT	Lab	PID		Well			
(ft.)	Туре	Rec.	or	D	(ppm)	Visual Description	Installation	Elevation		
	and	(ft. &	RQD	No.		Visual Description	Detail	(ft. MS' `		
	No.	%)								
-						Continued from Sheet 1	< cente	int T		
12							Bom	conita.		
13						-	Pel Pel	lats		
						-	- <b>1</b>			
14	•						2" PU	c		
15	N				.4	Drill to 21.0'(bgs)	riser			
16					.4	-				
							some			
17						-	pac pac			
18										
19						-	wall Scro	an m		
								<u> </u>		
20						_				
2121.0				•		γ				
22 -						End of Baring .	-			
	4					TD: 21.0'(695) -	piug -	-		
23							-	<del>.</del>		
24								فليبت		
25						-				
-										
26										
27						-				
28						-	4       -	<del></del>		
						-				
29						–				
30							1			
DRILLING (	0.: <u>P</u> e	rusti	t-100	oltt		BAKER REP.: J. E.	Zimmerman			
DRILLER:	_F	. Bus	h		ar na selar bir d	BORING NO.: <u>ოა</u> 3	<u>5534</u> SI	IEET 2 O		



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# TEST BORING AND WELL CONSTRUCTION RECORD

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Baker Enviror	nmental, me														
PROJECT: CTO NO.: COORDINA ELEVATIO	TES:	Tieata 323 EAST: SURFAC		<u>stu</u>	T yk.	<u>im - Situ</u>	BORI NORT	NG 1 TH:	NO.:		Plu M	000 Q 1W 35	C 53B		
RIG: # 8	2	<u></u>	<u>.                                    </u>	<del></del>	<u> </u>				PR	OGRESS			WAT	ER	
		SPLIT SPOON	CASIN	IG AL	JGERS	CORE BARREL	DAT	E		(FT.)	WE	ATHER	C DEP (FT		TIME
SIZE (DIA	M.)	1-3/8"		6	- 1⁄4"		8.25	96	0	- 32.0	10012	, ver 1 1 (80's'			
LENGTH		2.0			5.0	·····		<u> </u>		02.0	0.3011	N. (QQ) :	<u>-</u>		
TYPE		Std.			SA		1								
HAMMER	WT.	140 lbs.		1			1							<u> </u>	
FALL		30"													<u> </u>
STICK UP															
REMARKS	: Aug	ered t	0 5.0	2.600	<u>35).</u> S	awibia	s at	5'	in	i ev 12f	5 61	13:00	5.0'(6	95	) to
				n pac	x3600	und is		2012	•					-	
<b>6</b> -6		SAMPLE	TYPE			We		Dia	am.	Туре			Тор		Bottom
	Split Spo Shelby I			A = A W = W	•	Inform	ation						Dept		Depth
	Air Rota				Schedul					(ft.)	_	(ft.)			
	Denison	•		C = Cc P = Pis		Rise	Riser 2.0" Schedule			40		+ 3.0		-22.0	
		N = No S	ample			<u> </u>				Schedule	40			+	
						Scre	en	2.	0"	0.01 Slot			-22.	$\circ$	-27.0
Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)		Visual 1	Desc	ripti	on		Wel Installa Deta	tion		evation t. MSL)
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	MN 5-1 2	2.0 2.0 100%	30H 18 -		4/4	"local (orance) Blucin	CLA depa depa shgr	41 19 19 19 19 19 19 19 19 19 19 19 19 19	C L 1 				- groux - - - - - - - - - - - - - - - - - - -		
10										-			-		
	5-2	100%			.4./.4			M	atch	to Sheet 2		Ц			

DRILLING CO .: Parralt-wolff R. Bush DRILLER:

BAKER REP .: J.E. Zimmesman BORING NO.: <u>MW3553B</u> SHEET 1 OF 3

Baker Baker Environmental, me

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PROJECT:

CTO NO.:

Treatability	Study	In-situ	His	Sparging	Plume C
323				BORING NO .:	MW35538

[	SA	MPLE	<b>FYPE</b>			DEFINITIONS					
	plit Spoo	n		A = Au	-	SPT = Standard Penetration Test (A		:/0.5')			
	Shelby Tu			W = W		RQD = Rock Quality Designation (% PID = Photoionization Detector	6)				
	Air Rotar Denison	У		C = Co P = Pis		ppm = parts per million					
		I = No Sa	mple			FL- FF-					
Depth	Samp.	Samp.	SPT	Lab	PID		Well				
(ft.)	Туре	Rec.	OT	D	(ppm)	Visual Description	Installation	Elevation (ft. MS <sup>*</sup> `			
	and No.	(ft. & %)	RQD	No.			Detail	(10. 1415			
l	- 110.	2,0	2			Continued from Sheet 1					
	100	10,0	2 2		.4	CLAY WISOME Silt.					
	5-2		2 2		.4	Brownish gray, soft (little plastic), dowip	came				
12 12.0		100%	4				910				
13						_					
	N	-			.4	-					
14	10				.4						
15							2" PV				
15		2.0				CLAY WISOME Silt. Dork	riser				
16	100	20	NM		.4.	gray, soft (little plastic)	4				
	5-3		3		.4	damp.					
<u>ס,רו</u> 17 <u>17</u>		100%	4								
18						-					
					.4	_					
19	N	-			44	SAND, Pine to medium		onite			
						grained withace sit,-	Pal	iets			
2020,0		10	2			comented shall -		÷.			
21		1.0, 0,0	33		.4	material, trace shelt	15.55				
	5-4		1		.4	fragments. Brown to					
222		50%	1		• • • • • • • • • • • • • • • • • • •	yellowish brown to					
23	•					light greenish gray,	Sav	d -			
23					.4	dansa, wet _	pac	6			
24	N	-	-		.4/4						
						_		· ··· 7			
25 25.0	•		~				Well Scra	2.00			
26		1.9	8		.4,						
	5-5	2.0	9		.4	saws, fine to medium- grained, trace sit, -					
27	<u>,</u>	95%	10			1.1+10 to some comenta		<b>A</b>			
						Sandstone nodules, -					
28					.4	trace to some comented		_			
29	N	-	-		.4	shell mat. I fragments	Weit				
						Light graenish gray to	PIUS PIUS				
30 30.0	<u></u>		<u> </u>		<u> </u>	dense, wet.					
DRILLING	co.: <u>F</u>	arrat	t-w	<i>poltt</i>		BAKER REP.: J.E.	Zimmerman				
DRILLER:	<u>_</u> R	C. Bus	,h			BORING NO.: MW3	<u>5538</u> SF	IEET 2 O			



Baker Environmental, Inc.

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### TEST BORING AND WELL CONSTRUCTION RECORD

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PROJECT: CTO NO.:												
T = S $R = A$	Split Spoo Shelby Tu Air Rotar Denison	ıbe		A = Au $W = W$ $C = Co$ $P = Pist$	ash re	<u>DEFINITIONS</u> SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5') RQD = Rock Quality Designation (%) PID = Photoionization Detector ppm = parts per million						
Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)				
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	5-6	2.0 100%	\$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$		.4	Continued from Sheet 2 SFIND, fine graved ws   trace sitt, trace clay trace she'l mat, Greensh grav /white, damp End af Baring TD: 32.0' (bgs) 						
DRILLING	co.: <u>P</u>	arrat	t-4	poltt		BAKER REP.: J. E.	Zimmerma	^				
DRILLER:	5	2. Bus	5			BORING NO.: MW3	553B S	HEET 3 OF 3				



Baker Environmenta											RUCTION		JKD .
PROJECT: CTO NO.: COORDINATES ELEVATION:	: EA	323 AST: JRFACE		<u>Stu</u>	dy I	<u>in-Situ</u>	NORT	H:		<u>ging</u>	MW355	4- <b>A</b>	
RIG: #82							DAT	ъ	PRC	OGRESS	WEATHER	WATER	
		PDLIT POON	CASIN	G AU	GERS	CORE BARREL			(	(FT.)		(FT.)	
SIZE (DIAM.)	1	-3/8"		6	-74"		8.52-0	16	0	- 23.0	mostly cloudy, mild (60's)		
LENGTH		2.0			5.0								<b>ا</b>
TYPE		Std.		н	SA		<u> </u>						_
HAMMER WT	. 14	40 lbs.					<u> </u>						
FALL		30"					4						- <b></b> '
STICK UP							<u> </u>						
REMARKS: M	nge	red Spa	to s. sou s	o'Ch Sainni	35). [ 2125	braces	Colls Colls	$\sim$	5.0 e s.	(Cogs) KNULK	ores of	(legs) nd is .	Appm
S = Split T = Shel	Spoo		<u>TYPE</u>	A = A W = V	-	We Inform		Di	iam.	Туре		Top Depth (ft.)	Bottom Depth (ft.)
R = Air I D = Den	Rotary			C = C P = Pi		Ris	er	2	2.0"	Schedule PVC	40	+3.0	-18.0
	N	[ = No S	ample			Scre	en	2	2.0"	Schedule 0.01 Slot		-18.0	-23.0
(ft.) T	ump. ype ind No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm		Visual	Des	scripti	ion	Well Installati Detail	on	Elevation (ft. MSL)
1 2 3 /A- 4	2	-	unar		.4/.4	Mug	jer t	0	5.0'	-   (695)_ - -		grow!	
5 _5.0								¥	ر دوره ورسوره	-	ΗĤ	_	-

		I materia		<u>1</u> <u>7</u>
DRILLING CO.:	Parratt-wolff	BAKER REP.:	J.E. Zimmerman	-
DRILLER:	R. Bush	BORING NO.:	MW3554A	SHEET 1 OF

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1000 A 10 A 10

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# TEST BORING AND WELL CONSTRUCTION RECORD

11.4.1

PROJECT:       Treatability Study In-Situ Air Sparaing Plume_ BORNON:       Plume_State         Sample Sample       Sample Teshelby Tube       A = Auger W = Wash R = År Rotary       SPT = Standard Penetration Test (ASTM D-1586)(Blowg0.5) RD = Pension         N = No Sample       C = Core D = Denison       P = Piston         Depth       Samp. SPT and (R).       SPT = Standard Penetration Test (ASTM D-1586)(Blowg0.5) RD = Pension         N = No Sample       SPT = Standard Penetration Test (ASTM D-1586)(Blowg0.5) RD = Pension         Depth       Samp. SPT and (R).       SPT = Standard Penetration Test (ASTM D-1586)(Blowg0.5) RD = Pension         11       N = No Sample       PD = Piston         12       No.       SPT = Standard Penetration Detector pm = parts per million         13       No.       Solution State Interval         14       Interval       Continued from Sheet I       Caluer and Astronometry         15       N       -       -         16       N       -       -       -         17       Interval       Interval       Interval       Socradian         18       Interval       Interval       Interval       Interval         19       Interval       Interval       Interval       Interval         21       Interval       Interval<	Oaker Environn	ICIHUI, Int						
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$		Т _	Teatal 323	bility	Stuc	by In	-Situ Air Sparging BORING NO.:	Plumec MW3554A
Depth (ft.)Samp. Type and (ft. $\frac{1}{N}$ (ft.)Samp. Rec. and (ft. $\frac{1}{N}$ (ft.)Samp. Structure (ft.)Samp. Structure (ft.)Well (ft.)Elevation (ft.)11	T = S $R = A$	plit Spoo helby Tu hir Rotar Denison	on ibe y		W = W C = Co	/ash ore	SPT = Standard Penetration Test RQD = Rock Quality Designation PID = Photoionization Detector	(ASTM D-1586)(Blows/0.5')
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$		Samp. Type and	Samp. Rec. (ft. &	SPT or	ID	1	Visual Description	Installation Elevation
	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	λ.				4/4	V End of Boring TD: 23.0' (bgs)	Bentonite Periodic Bentonite Periodic Sava pock Screen 
	DRILLING CO				<u> 117</u>			

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ROJECT: CTO NO.: COORDINA CLEVATION	res: E	AST: URFACE		STUS		<u></u>	NORT	H:		ASING:	<u>Mw</u>	3554	В	
<b>RIG:</b> # 82									PRO	GRESS			WATE	
<u> </u>		SPLIT POON	CASIN	G AU	GERS	CORE BARREL	DAT	E		FT.)	WEA	THER	DEPTH (FT.)	I TIME
SIZE (DIAN	1.)	1-3/8"		6.1	4"		8-24-	96	0-	- 17.0	veryux	cioudy, aim <b>(80</b> 5)		
LENGTH		2.0		5	0		8-25	- 96	17-	32.0	mostly mild (	cloudy, (60'5)		
TYPE		Std.		H	SK									
HAMMER	WT. 1	40 lbs.					<u> </u>				ļ			
FALL		30"					<u> </u>							
STICK UP					l		<u> </u>				<u> </u>			
REMARKS	: Auge (695)	red t	o s.o backg	Lorru	1. Sam	pled of the second	at s. tpp://	⊃' . +<	inte a .S	ppin.	ticom	. 5.010	695) to	
	<u>S</u> plit Spo helby T		<u>TYPE</u>	A = Aı W = W		We Inform		Di	am.	Туре			Top Depth (ft.)	Bottom Depth (ft.)
$\mathbf{R} = \mathbf{A}$	Air Rotar Denison			C = Cc P = Pis	ore	Ris	ег	2.	.0"	Schedule PVC	e 40		+ 3, 0	-22.0
	1	N = No Sa	ample			Scre	en	2.	.0"	Schedule 0.01 Slo			-22.0	-27.0
Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)		Visual	Des	cripti	on		Well Installati Detail		Elevation (ft. MSL)
1 2 3 4 55.Q	A-N	-				Auge	s to	S.C	s' (l	- 9 <i>32)</i> -			-   endi	
6 77.0	5.1	NR	3012		.5/ .5	NO	Rac	5-7-6	25 4				2" puc riser	
8 9 10	N	-												
10 10/0	5-2	100%			.5/.5			N	Match	to Sheet	2	Ľ	1	

DRILLER:

R. Bush

BORING NO.: MW3554B SHEET I OF 🛲



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T = S R = A	plit Spoo helby Tu Air Rotar Denison	ibe		A = Au $W = W$ $C = Co$ $P = Pis$	ash re	<u>DEFINI</u> SPT = Standard Penetration Test (A RQD = Rock Quality Designation (? PID = Photoionization Detector ppm = parts per million	STM D-1586)(Blows	\$/0.5')
Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL
11 1212.0	5-2	20/20 100%	Wok 24"		.5	Continued from Sheet 1 CLAY WILLET Silt, tr. Sand, fine grained Oxidation (orange brown) Staining, Gray Very Soft (plactic)		
13 14 1515.0	N.	_			.5/.5			
16 16 177.0	5-3	Z.0 Z.0 100%	12" 12" 2		.5	CLAY WISilt Dark _ Olive gray, very soft _ (plastic), moist _	2"S	C
18 19	N				.4		Bewt	ounite 245
20 <u>20.0</u> 21 <u>-</u> 22 <u>22.0</u>	5-4	1.4 2.0 70%	2231		.4.	SAWD, fine to medium grained wittace sitt commented shell -		
23 24 2525.c	N	-			.4	matarial, traca Shari fragments Brown to yellowish brown to light graanish gray, loosa		a K
26 27	5-5	1.8 2.0 90%	4206		.4	to medium dense, wat. SAWD, fine to medium grained, trace silt,		đ٧
28 29 3030	N	-	-		.4/4	little to some cementer sandstone nodules, trace to some cementer shell mat. (fragments light greenish gray to light gray/white, med	La weit	



### PROJECT: CTO NO.:

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TEST BORING AND WELL CONSTRUCTION RECORD

Treatability Study In-Situ Air Sparging Plume C 323 BORING NO .: MW3554B

	T = 5 R = 2	Split Spoo Shelby Tu Air Rotar Denison	ibe y		A = Au $W = W$ $C = Co$ $P = Pis$	ash re	DEFINIT SPT = Standard Penetration Test (AS RQD = Rock Quality Designation (% PID = Photoionization Detector ppm = parts per million	STM D-1586)(B	lows/0.5')
<del>-</del>	Jonth		l = No Sa	SPT	Lab	PID	······································		
	Depth	Samp.	Samp. Rec.	or	ID			Well	Elevation
	(ft.)	Type and	(ft. &	RQD	No.	(ppm)	Visual Description	Installation	(ft. MSL)
		No.	(IL & %)	кųр	140.			Detail	
		140.	/0)	10			Continued from Sheet 2		
31	-	_	N. N.	10		.4	SAND Fine grained, tr.		-1 T
54	-	5-6	5'0	13			silt, tr. clay, tr. shell		
32	- 32.0		90%	13		1.4	Silt, tr. clay, tr. Shell mat. Greenish gray/white medium dense, damp		-
22	- 520		1075	·					
22	-					İ	End of Boring -		-
33									
	_								
34	_	· ·					TD: 32.0' (bgs) _		T
	4						-		- I.
35									
	4						-		
6									
	_						_		
7							_		
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0		l	I	l	<u> </u>	I			
DRI	LLING (	co.: <u> </u>	arra	<u>tt-u</u>	201ff	· · ·	BAKER REP.: J.E. Z	immerman	1
יתח	1100.	τ	. Bus					SAR	
DIG	LLER:	_K	·· UUS	<u> </u>			BORING NO.: <u>MW35</u>		SHEET 3 OF



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Baker Environmental												_		
PROJECT:	TE	eatal	sility	Stu	dy I	<u>In-Situ</u>	<u>Hir</u>	500	<u>ru</u>	<u>zina F</u>	NW355	<u><u></u> <u></u></u>	<u>.</u>	
CTO NO.:							NORTI		).:		<u>MW 555</u>		<u>\</u>	
COORDINATES ELEVATION:		JRFACE	:						СС	ASING:			· · · · · ·	
RIG: ₩82							DAT	E P		GRESS	WEATHE	R	WATER	1 1
		PLIT POON	CASIN	G AU	GERS	CORE BARREL			(	FT.)			(FT.)	
SIZE (DIAM.)	1	-3/8"		6-	/4.''		8-24-4	76 0	э.	.12.0	clear, warn humid (70"	ŝ		
LENGTH		2.0		5.										
TYPE		Std.		F(1	SA .									_
HAMMER WT.	14	10 lbs.												
FALL		30"												
STICK UP									:					
REMARKS: AL	ide, ide,	red ;	to 12 7.0° (t	2010, CP	gs). Wiy.	Split s HNUL b	la c leg	101 101	~~~ ~~ (	pla ca	sciected	4	1000	י סיר
	10	MPLE				We	11	Dian		Туре			Тор	Bottom
S = Split				A = Au		Inform	ation						Depth	Depth
T = Shelt				W = W C = Co						01.11			(ft.)	(ft.)
R = Air R $D = Deni$	son			C = Co P = Pis		Rise	er	2.0'	'	Schedule PVC			+3.0	-7.0
	N	= No Sa	umple			Scre	en	2.0'	,	Schedule 0.01 Slot			-7.0	-12.0
(ft.) T	mp. ype nd Io.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm		Visual 1	Descri	ipti	on	Wa Instal Det	latio	nn I	Elevation (ft. MSL)
$ \begin{array}{c} 4 \\ - \\ 5 \\ - \\ 6 \\ - \\ 7 \\ - \\ 7 \\ - \\ - \\ - \\ - \\ - \\ - \\ - \\ - \\ - \\ -$	2	- i	- 2		· · / · ·	Sandy C	ا اس۲ کما	5000	٩ 5	- - -			2000	iita
8 <u> </u>	- 1	2.0 50%	332		.5	gray	e sut	ι. Ōκ	:9s	ed w <u>l</u> ition Blueish e, moist			sound ack	
10 <u>-</u>	N	-mp.	-		.5/	Muge				bgs) _ to Sheet	2		011_ CT201	

DRILLING CO.:	Parratt-wolff	BAKER REP.:	J.E. Zimmerman	·
DRILLER:	R. Bush	BORING NO .:	MW3555A	SHEET I OF 2

Baker

Baker Environmental, 👳

SAMPLE TYPES = Split SpoonA = AugerDEFINITIONST = Shelby TubeW = WashSPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5')R = Air RotaryC = CorePID = Photoionization DetectorD = DenisonP = Pistonppm = parts per millionN = No SampleVisual DescriptionWellLabPIDVisual Description	PROJECT: CTO NO.:	Ţ	<u>raata</u> 323	<u>ibilit</u>	y Stu	dy I	<u>n-Situ Air Sparging</u> BORING NO.:	Plume C MW3555A	
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	r								
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	T = S $R = A$	Split Spoo Shelby Tu Air Rotar Denison	on ibe y		W = W C = Co	ash are	SPT = Standard Penetration Test (A RQD = Rock Quality Designation ( PID = Photoionization Detector	ASTM D-1586)(Blow	vs/0.5')
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$		Type and	Rec. (ft. &	or	ID	1	-	Installation	Elevation (ft. MS' ~
	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	K-N				. 5/5	Muger to 12.0'(693) - End of Roring -	Scree Save Pac	4
	27 28 29								

DRILLER: <u>R. Bush</u>

mmerma

BORING NO.: MW3555A SHEET 2 O



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R. Bush

DRILLER:

### TEST BORING AND WELL CONSTRUCTION RECORD

Tract Schult 1: Stating Tract Schult, M. (1. Spanishop Phame C.         CTO NO:       PROPERT:       Mub2d Schult         COORDINATES: BAST:       Mub2d Schult       Mub2d Schult       Mub2d Schult         RIG:       PROPERT:       Mub2d Schult       Mub2d Schult <th c<="" th=""><th>Baker Environme</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th>,</th><th>(T)</th><th>(</th><th>~</th><th></th></th>	<th>Baker Environme</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th>,</th> <th>(T)</th> <th>(</th> <th>~</th> <th></th>	Baker Environme										,	(T)	(	~	
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $			<u>Tranti</u>	abilit.	4 54	VQA	In-Si	the P		<u>&gt;p</u>	ardind	<u> </u>	NOME (	<u> </u>		
CORRENT OF OF PVC CASING:         TOP OF PVC CASING:         RIG: # $\Im_2$ SPLIT       CASING       AUGERS       DATE       PROGRESS       WEATHER       DATER         SPOON       CASING       AUGERS       CORE       DATE       PROGRESS       WEATHER       DEPTH       TIME         SIZE (DIAM.)       1.38"       (G. VA."       8-25.9C      32.0       Kuat (Bors)										10.:			<u>103333</u>			
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $				 							ASING:					
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	ELEVATION:	. ა	UKrACI	······································				101 0							· · · · · · · · · · · · · · · · · · ·	
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	RIG:													WATE	2	
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	# 85								Е			WE	ATHER		1 1	
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$				CASIN		GERS				(	FT.)					
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$							BARREL									
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	SIZE (DIAM	.)	1-3/8"		<u>6</u> .	1/4"		8-23.	96	0-	32.0	hun	.id (80'S)			
HAMMER WT.140 lbs.140 lbs.FALL30"Image: Second State St	LENGTH				5	. O										
FALL30"STICK UPSTICK UPREMARKS: Augered to 5.0' (bgs). Sampled at 5' intervols from 5.0' (bgs) to 32.5' (bgs). HNAL background is $\cdot \leq p pm$ SAMPLE TYPE S = Split SpoonMellSAMPLE TYPEWellDiamThe Shelby TubeWellDiamTypeTop DepthBottom 	TYPE				<u> </u>	SA										
STICK UPREMARKS: Augered to S.O' (bgs). Sawpled at S' Intervals from S.O' (bgs) to 22.5' (bgs). How background is S PPMSAMPLE TYPESAMPLE TYPESample Teshelby TubeWell InformationDephDephN = No SampleVelSchedule 40 PVCTop DephBottom DephN = No SampleVisual DescriptionWell RiserDeph Schedule 40 PVCVisual DescriptionWell Rec. or and (ft.)(ft.)Schedule 40 PVC-21:0 -2:0Depth Samp. Samp. SPTLab PID (ppm)Visual DescriptionWell Installation DetailInformation Rec. or and (ft. & RQD No.No.Schedule 40 PPD Oll Slot-21:0 -2:0Sample Samp. SereenSPT I Lab (ft.)Well Installation DetailInstance Installation DetailVisual DescriptionWell Installation DetailInstance Installation Installation DetailSchedule 40 Installation DetailInstance Installation Installation DetailVisual DescriptionInstance Installation Installation Install		VT.														
REMARKS: Augered to 5.0' (bgs). Sampled at 5' intervals from 5.0' (bgs) in3.0' (bgs). Hisu background is .5 ppmSample Sample to 5.0' (bgs). Hisu background is .5 ppmSample TopBottomSample to 5.0' (bgs). Hisu background is .5 ppmSample TopBottomSampleSampleSampleNew and the weakRec. orDepthSampleSchedule 40DepthSampleSchedule 40OF 200 Schedule 40Schedule 40OF 200 Schedule 40Schedule 40OF 200 Schedule 40Schedule 40Schedule 40 <th colspa<="" td=""><td></td><td></td><td>30"</td><td></td><td></td><td></td><td></td><td><u> </u></td><td></td><td></td><td><u></u></td><td> </td><td></td><td></td><td></td></th>	<td></td> <td></td> <td>30"</td> <td></td> <td></td> <td></td> <td></td> <td><u> </u></td> <td></td> <td></td> <td><u></u></td> <td> </td> <td></td> <td></td> <td></td>			30"					<u> </u>			<u></u>				
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	STICK UP															
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	REMARKS:	Auge	ered 1	0 5	0' (69	)S). S	sample	d at	: 5'	10	42500	12	+ LOW	5.0.0	ogs) to	
S = Split Spoon T = Shelby Tube B = Dirbota D = DenisonA = Auger W = Wash C = Core P = PistonInformationDepth (ft.)De					<u> </u>	JCK.d.	round w	15 . 5	99 105	¥///\	Time	<b>.</b>		Top	Bottom	
T = Shelby TubeW = WashR = Air Rotary D = DenisonC = Core P = PistonRiser2.0"Schedule 40 PVC21.0Depth 	S - S-			TYPE	$\Delta = \Delta$	nger				<b>4</b> 11.	туре			-		
$\begin{array}{c c c c c c c c c c c c c c c c c c c $						~		1441011								
$\begin{array}{c c c c c c c c c c c c c c c c c c c $										<b>A</b> 11	Schedule	: 40				
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	D = D				P = Pi	ston		ser	2.	0	PVC			+ 3.0	-21.0	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $		•	N = No S	ample			Scr	een	2	0"	1			<b>.</b>		
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$											0.01 Slot	t 		- 2/0	- 26,0	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $		_	· ·												Elevation	
No. %) No. %) 1 = 1 2 = 1 3 = 1 4 = 1 5 = 5.0 1.7 1 = 1 5 = 5.0 1.7 1 = 1 5 = 5.0 1.7 1 = 1 1.7 1 7 1 = 1 1.7 1 7 1.7	(n.)			1		(ppn	"	Visual	Desc	cripti	ion			on		
$\begin{array}{c} 2\\ 2\\ 3\\ 3\\ -1\\ -1\\ -1\\ -1\\ -1\\ -1\\ -1\\ -1\\ -1\\ -1$			1 1		1.00		ļ					ŀ	Detail		` ´	
$\begin{array}{c} 2\\ 2\\ 3\\ 3\\ -1\\ -1\\ -1\\ -1\\ -1\\ -1\\ -1\\ -1\\ -1\\ -1$											-	17		_		
3 - A - N $4 $ $5 - 5 - 1$	1											+				
3 - A - N $4 $ $5 - 5 - 1$												+1		_		
3 - A - N $4 - S - S - S - S - S - S - S - S - S -$	2										<u> </u>	+1	H	212.2	~ <del>+</del>	
4 - 5 - 5 - 1 - 7 - 20 - 5 - 1 - 7 - 20 - 85% $3 - 5 - 1 - 7 - 20 - 85%$ $3 - 5 - 1 - 7 - 20 - 85%$ $3 - 5 - 1 - 5 - 1 - 5 - 1 - 5 - 5 - 5 - 5$						1.5,	Auge	r to	5.0	' ( L	ogs1.	-1				
$5  5.0 \qquad 1.7  1.7  1.5 \qquad 5andy CLAY w(some) \\ 5  5.1  2.0  1.5 \qquad 5itt. Oxidation (dark) \\ 7  7.0 \qquad 85\% \qquad 3 \qquad .5 \qquad 10cal deposits and streaks. Blue ish gray to greenish gray, soft (little plastic), damp \\ 8  10  5.2  65\% \qquad .5/.5 \qquad Match to Sheet 2 \qquad .5$		H-N		-		1/.5			1	-	· · ·	+1	2	2.22		
$5  5.0 \qquad 1.7  1.7  1.5 \qquad 5andy CLAY w(some) \\ 5  5.1  2.0  1.5 \qquad 5itt. Oxidation (dark) \\ 7  7.0 \qquad 85\% \qquad 3 \qquad .5 \qquad 10cal deposits and streaks. Blue ish gray to greenish gray, soft (little plastic), damp \\ 8  10  5.2  65\% \qquad .5/.5 \qquad Match to Sheet 2 \qquad .5$												+1	М			
$6 = 5 \cdot (1,7) + 1 = 5$ $5 \cdot (1,7) + 1 = 5$											-	$\square$				
$6 = 5 \cdot (1,7) + 1 = 5$ $5 \cdot (1,7) + 1 = 5$						1			V			11		4		
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	3 _ 3.0		1,7	1			Sand	N CL	49	wi	some					
$7  70 \qquad 85\% \qquad 5172a ks. Blueish gray 7  70 \qquad 85\% \qquad 715er \\ 10  700 \qquad 715er \\ 10  715e$			- All and a second			.5		. Oxid	lati	00	(dark	1				
$7  70 \qquad 85\% \qquad 5172a ks. Blueish gray 7  70 \qquad 85\% \qquad 715er \\ 10  700 \qquad 715er \\ 10  715e$		5-1					. brou							Z" PVC		
8 9 10 10 5-2 65% 5/5 15			85%	, D										riser		
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$							+0	green	ish	900	24, Sof	Ŧ				
9 $\frac{1}{5}$ $\frac{5}{5}$ $\frac{1}{5}$ $\frac{5}{5}$ $\frac{1}{5}$ $$							(1,41	for bu	asti	(c),	gamb					
$10 - \frac{100}{5-2} - \frac{100}{5-$						.5	,									
$10 - \frac{100}{5-2} - \frac{100}{5-$	9 ]			1		.c	5				_					
5-2 65% ·5/.5 Match to Sheet 2												$\square$		_		
	10 /0.0											$\downarrow$	И			
DRILLING CO. Propart - Walls RAKER RED. T.F. Zimman sunda		5-2	65%	6		.5/.	5		N	/latcl	1 to Sheet	2				
			D		2214			D VI	ם קב	ED.	TF	2	VAA C Para	<b>0</b> 10		

BORING NO .: MW35558 SHEET I OF 3



Treatability Study In-Situ Air Sparging Plume C PROJECT: CTO NO .: BORING NO .: MW35558 323 SAMPLE TYPE DEFINITIONS SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5') S = Split SpoonA = Auger T = Shelby Tube W = WashRQD = Rock Quality Designation (%)  $\mathbf{R} = \mathbf{Air Rotary}$ C = CorePID = Photoionization Detector  $\mathbf{D} = \mathbf{Denison}$  $\mathbf{P} = \text{Piston}$ ppm = parts per million N = No SampleDepth Samp. SPT Lab PID Samp. Well (ft.) Rec. ID Type or (ppm) Elevation Installation Visual Description (ft. & RQD No. and (ft. MS' ` Detail No. %) 1.3 Continued from Sheet I .5/5 SAND, fine grained wi trace sitt. Gray, very -11 2.0 5-2 ş 65% 1005c, uset centent 12 12.0 grout 13 .5/5 14 PU 2" 15 15.0 N N W 1. O rise SAND, five grained L 16 .5 2.0 willittle to some 5-3 Silt. Brownish groy ł 50% 17.0 17 loose, wet 18 Benkonite .5 .5 pallats 19 20 20.0 1.1 6 21 2.0 ·5/ .5 5-4-SAND, fine to medium 4 grained withace silt, Sayid 55% 1 22 22.0 padk commented shell mat 1,440 comented sand-23 stone nodules, trace .5 shall fragments. Brownish gray to brown/white 24 well scralen medium dense, wet 25 25.0 1.2 16 SAND, Fine grained ( 14 CEMENTED SHELL ·5/ ·5 26 2.0 5-5 10 MATERIAL / SHELL FRAGMENTS WITTACE 60% 11 27 27.0 silt. Light gray / white medium danse, wet 28 .5 .5 walt 29 plug 30

DRILLING CO .: Parratt-Wolff

J.E. Zimmerman BAKER REP .:

DRILLER:

R. Bush

BORING NO .: MW35558

SHEET 2 C



PROJECT: CTO NO.:

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Treatability Study In-Situ Nir Sparging Plume C 323 BORING NO .: MW3555B

T = R =	Split Spot Shelby Tu Air Rotar	ıbe	ГҮРЕ	A = Au $W = W$ $C = Co$	ash re	DEFINIT SPT = Standard Penetration Test (A RQD = Rock Quality Designation (% PID = Photoionization Detector	STM D-1586)(Blow	s/0.5')
D=	Denison	I - Ma Sa	mala	$\mathbf{P} = \mathbf{Pis}$	ton	ppm = parts per million		
Depth		I = No Sa Samp.	SPT	Lab	PID			
(ft.)	Samp. Type and	Rec. (ft. &	or RQD	ID No.	(ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)
	No.	%)					Ecuit	
31	5-6	n/n	11 14 15		.5 .5	Continued from Sheet 2 SAND, fine grained, tr. silt, trace clay, tr. shell material. Greening gray/while, nich. dense. ion		
3232.	s	100%	13			gray/while, med. dense, non	P	
33 _						End of Boring _		
34						TD: 32.0' (bgs) -		
35 _								
6								
7								
8								
						-		
2						-		
.3							-	
4						-		
5 _								
:6								
7								
8 _						_		
9								
						l		l
DRILLING	co.: <u> </u>	Ser134	t-10	0199		BAKER REP.: J. E.	Zimmermo	۸
DRILLER:	<u>[</u>	R. Bus	h			BORING NO.: MW3	<u>555B</u> s	HEET 3 OF 3



PROJECT:		- Troat:	skateks		du T	n-Sil.	. 111	e . 10	· ca		Plume MW355	C	(
CTO NO.:	-	323	1.10.1.1.1	<u></u>	-1 <u>1</u>		BORD	NG	NO.	<del>-33</del> -	MW355	68	
COORDINA'		EAST:					NORT	H:					
ELEVATION		SURFACE	5:						VC C	CASING:			
RIG:												WATE	,
*83	) •			·····			DAT	Е		OGRESS	WEATHER		· •
		SPLIT SPOON	CASIN	IG AU	GERS	CORE BARREL			•	(FT.)		(FT.)	
SIZE (DIAM	<i>A.</i> )	1-3/8"		6-1	/4 "		8-23-	96	0	-34.0	clear, mild (60's)		
LENGTH		2.0			0								
TYPE	Î	Std.			EA								
HAMMER	WT.	140 lbs.										·	
FALL		30"											
STICK UP													
REMARKS:	: Augo 32.0	cred t	20 5.0 ). HN	r (bgs. n bac	j. Sam kgrou	pled a no is	.t 5 .5 pp	1th	dea	vals f	from 5.0'	(bg:) t	<u></u>
· · · · · · · · · · · · · · · · · · ·		SAMPLE				We			iam.	Туре		Тор	Bottom
S = S	plit Spo			A = Au	ıger	Inform						Depth	Depth
	helby 7			W = W								(ft.)	(ft.)
	Air Rota Denison	•		C = Co P = Pis		Rise	er	2	.0"	Schedule PVC	e 40	+3.0	-15.0
		N = No S	ample			Scree	en	2	.0"	Schedule 0.01 Slot		-15.0	-25.0
Depth	Samp.	. Samp.	SPT	Lab	PID			ł			Wel	, I	
(ft.)	Type and	(ft. &	or RQD	ID No.	(ppm)		Visual	Des	cripti	on	Installa Deta	tion	Elevation (ft. MSL)
	No.	%)											
										_			L
	-									-		center	-
2									,	. –		grout	
	A-N		-		.5/5	Auge	r to	5	$\mathcal{O}$	(bgs) -		_	
3	<b>n</b> 10				(·.>					_		_	•
								i		-		2" PUC	
4		1										riser	
5 5.0								.1		-	4	····-	
3 - 3.0	an	1.2	HOLU			e	100	<b>7</b>					
6		1.3	12"		.<	sinty C sand	LUNT Lin	ردی م	sur l	ined.		-	
× −	5-1	L'N			.5/5					, very		$\dashv$	
7 7.0		65%	Z			Soft	, we	5	4		T	-	
		<u>~</u>											-
8 -										-		4	
												-	
9 _	N									-		-	-
													· ·
10 10.0										-	國國、	Benton	ite.
	5-2	55 %		_	.5/.5			N	fatch	to Sheet 2		partat	5
			t-w						EP.:		Zimmer		

DRILLER:

R. Bush

BORING NO.: MW35568 SHEET I OF 🗯

# Baker

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### TEST BORING AND WELL CONSTRUCTION RECORD

TO NO.:		323	<u>,</u>			<u>n-Situ Air Sporging</u> BORING NO.: _	MW3556B				
T = S R = A	Split Spoo Shelby Tu Air Rotar Denison	ıbe		A = Au $W = W$ $C = Co$ $P = Pis$	ash ore	DEFINITIONS SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5') RQD = Rock Quality Designation (%) PID = Photoionization Detector ppm = parts per million					
Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT oʻr RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)			
11 1212.0 13	5-2	11/20 %	NMM4		.5/5	Continued from Sheet 1 CLAY WILLELE Site, tr. Sand, fine grained Oxidation Corange brown) Staining. Gray- soft to medium stiff moist		ovite ets c			
14 15 <u>15.0</u> 16	N. 5-3	·8/2.0	2333			SAND, fine grained witrace sitt. Greenish	Sari 200	H K			
17 <u>17.0</u> 18 <u>-</u> 19 <u>-</u>	N	40%	3			3(0×,1005e,wet		en			
$\begin{array}{c} 20 \\ - \\ 21 \\ - \\ 22 \\ $	5-4	1.4 2.0	- 3) 17 54		in lin	SANC, Fine to medium grained witrace site comented shell mat. tr. shell frags					
23 24 2525.0	N					SAND, fine to medium grained, fr. silt, little to some convented sandstone nodules Brown I yellowish brown light greenish gray while					
26 2727.0	5-5	1.6/2.0	5 7 S		:×/.	SAND, fine grained/_ CEMENTED SHELL_ MATERIAL   SHELL_					
28 29	N					FRAGMENTS withog silt. Light gray _ and white, medium dense, wet _					

DRILLING CO .: Portatt- Wolff BAKER REP .: J.E. Zimmerman

DRILLER:

R. Bush

BORING NO.: MW3556B SHEET 2 OF.



PROJECT: CTO NO.:

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Treatability Study In-Situ Hir Sporging Plume C 323 BORING NO .: MW3556B

$\begin{tabular}{lllllllllllllllllllllllllllllllllll$						<u>DEFINITIONS</u> SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5') RQD = Rock Quality Designation (%) PID = Photoionization Detector ppm = parts per million					
Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	SPT or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)			
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	5-6 5-7	1.8. N. 0.0. 1.8. N. 0.0. 1.9.	7352 1455		.5/5	Continued from Sheet SANDO, fine to medium grained CEMENTED SHELL MATERIAL   SHELL FRAGS tr. sit, micrite. Light gray to white, mediane dense, uset SANDO, Fine grained, trac cloy. down End of Boring TD: 34.0' (bgs)					
7 8 9 0											
DRILLING				Solft			Zimniarman				
DRILLER:	1	<u> R. Bus</u>	ih			BORING NO.: <u>MW3</u>	<u>5568</u> s	HEET 3 OF			



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### TEST BORING AND WELL CONSTRUCTION RECORD

BakerEnviron														
PROJECT: CTO NO.: COORDINA	TES:	EAST:		( Stu	dy I	<u>n-Siku</u>	NORT	H:		<u>, enic</u>	Plun Mu	<u>~q_C</u> )355	פר	
ELEVATION	N: :	SURFACE	E:				TOP O	)F PV(	CC	CASING:			<u></u>	
RIG: #87	2					<u></u>	DATE PROGRESS		WEA	THER	WATE			
		SPLIT SPOON	CASIN	G AU	GERS	CORE BARREL			(	(FT.)			(FT.)	
SIZE (DIAN	M.)	1-3/8"		6-1	4"		8-22-	96 (	2-	32.0	partiv vary w	1 Cloudy Darm (80	s <b>.</b>	
LENGTH		2.0		5.	0								ļ	
TYPE		Std.		<u> </u>	SA		<u> </u>						ļ	_
HAMMER	<u>wt.</u>	140 lbs.					<u> </u>							
FALL		30"					<u> </u>							
STICK UP													1	
REMARKS	: Augo 32.0	sied t	0 5.0 ). HNI	r pac	). San Kgrou	. vac. 1 %	· 4 ¢	stan. Not		1.1015	400	m 5.1	o.(pdi	5) to
	-	SAMPLE	TYPE			We		Dian	1.	Туре			Тор	Bottom
	Split Sp			A = Au $W = W$		Inform	ation						Depth	
1	Shelby T Air Rota			w = w C = Cc				<u> </u>		Schedule	40		(ft.)	(ft.)
1	Denison	•		P = Pis		Ris	er	2.0'	4	PVC	40		+3.0	-17.0
		N = No Sa	ample					0.01	1	Schedule	40			
						Scre	en	2.0'		0.01 Slot			-17.C	-27.0
Depth	Samp	-	SPT	Lab	PID							Well		
(ft.)	Type	Rec. (ft. &	or RQD	ID No.	(ppm)		Visual	Descri	ipti	ion		Installat		Elevation (ft. MSL)
	and No.	(IL & %)	I NQD	140.								Detai	1	
1													jeme	
2 3	A-N		_		.4/.4	Auge	red -	to s I	5.C	»'(bgs <u>)</u> _		5	- - -	. <b>t</b>
4													-	
5 5.0		12	-					) 			$\uparrow$	1		1
6	_	1.2	WOH		4					irace.		Π	-	
	5-1		24"		.4				*				_	
77.0		60%	1		.+				Q.	1, very			2" PUZ	
			1		1	204	t, m	0154		_			riser	
8			1							-			-	
	N				.4									
9					.4.					_		Ĺ		
													_	
100.0	-				ļ.,							$\square$		
	5-2	NR			.4/.4	<u> </u>		Ma	tch	to Sheet	2			
DRILLING	CO.: _	Parra	tt-h	olff			BAKE	ER REI	P.:	JE	Zin	mari	man	

DRILLER:

R. Bush

BORING NO .: MW3557B SHEET 1 OF 3

Baker

Baker Environmental, #c

PROJECT:	Treatability	Study	In-Situ	Nis	Sparaina	Plume C
CTO NO.:	323				BORING NO.:	MW3557B

		MPLE	TYPE			DEFINIT		
	Split Spoc Shelby Tu		÷	A = Au $W = W$		SPT = Standard Penetration Test (A RQD = Rock Quality Designation (%		/0.5')
R = 4	Air Rotar			C = Co	ore	PID = Photoionization Detector	- /	
D = 1	Denison N	l = No Sa	mnle	$\mathbf{P} = \mathbf{Pis}$	ton	ppm = parts per million		
Depth	Samp.	Samp.	SPT	Lab	PID		Well	
(ft.)	Type and	Rec. (ft. &	or RQD	ID No.	(ppm)	Visual Description	Installation	Elevation (ft. MS <sup>*</sup> `
	No.	(II. & %)	RQD	INU.			Detail	(II. MIS
11			NOCH			Continued from Sheet 1	cense gra	nt
	5-2	NR	12"		.4	No		
12 12.0	·····		1-1			LANDON L		
13						-	Bentle perive	
14	N.				.4			-
					.4			
15 _15.0		1.9	WOK		-	CLAY W(Silt	sav	4 -
16	5-3	20	18		.4.4	Greenish gray, -	Pod	
17		95%	j		.4	very soft, moist -		
18						-		
-	N				.4	-		
19					.4			
20 20.0								
21		10.0	2		.4	SAND, fine grained _ WILLTHE silt. Dark-		
2222.0	5-4	50%	23		.4.4	gray, loose, wet -		
23					.4	_	SCLO	Lan
24	N				.4	-		
2525.0						-		
_	······	1.8	7 10			SAND, fine to medium		-
26	5-5	2.0	13		.4	grained, tr. silt, cementad		. •
27270	1	90%	15			Shell fragments.		
28						SAND, fine to medium		
29	N	1			.4	little cemented Sandstone nodules	plug	-
30 30.0						ts to little cemented shells -		
DRILLING		arrai	et-u	solft		$=$ BAKER REP.: $J \in \mathcal{J}$	Zimmerman	
		. Bus						
DRILLER:	75	· ous	<u>n</u>			BORING NO.: $\underline{M}\underline{W3}$	SH	EET 2 O

Baker

## TEST BORING AND WELL CONSTRUCTION RECORD

contraction conceptuation of the second seco

PROJECT: CTO NO.:														
T = R =	Split Spoo Shelby Tu Air Rotar Denison	ıbe		A = Au $W = W$ $C = Co$ $P = Pis$	ash re	DEFINITIONS SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5') RQD = Rock Quality Designation (%) PID = Photoionization Detector ppm = parts per million								
Depth (ft.)	Samp. Type and No.	Samp. Rec. (ft. & %)	or RQD	Lab ID No.	PID (ppm)	Visual Description	Well Installation Detail	Elevation (ft. MSL)						
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	5-6	ia/2.0 90%	0 g r 0		·4/.4	Continued from Sheet : SAND, fine grained, tr. Site, tr. clay, tr. Shell moterial. Greenish gray/- white, medium danse, damp End of Boring 								
0			 + - 1.x			BAKER REP.: J. E. Z								

DRILLER:

R. Bush

BORING NO.: <u>MW35578</u> SHEET30F3



RIG: # 32.PROGRESS WEATHERWEATHER DEFTH (FT.)WEATHER DEFTH (FT.)WEATHER DEFTH (FT.)WEATHER DEFTH (FT.)WEATHER DEFTH (FT.)SIZE (DIAM.)1-38°CORE DATEPROGRESS (FT.)WEATHER DEFTH (FT.)WEATHER DEFTH (FT.)WEATHER DEFTH (FT.)TIMESIZE (DIAM.)1-38°CORE DATEPROGRESS (FT.)WEATHER DEFTH (FT.)TIMESIZE (DIAM.)1-38°CORE DATEPROGRESS (FT.)WEATHER DEFTH (FT.)TIMESIZE (DIAM.)1-38°CORE DATEPROGRESS (FT.)WEATHER DEFTH (FT.)TIMESIZE (DIAM.)ACC (A '14')BARRELDATEPROGRESS (FT.)SITCK UPSAMPLE TYPE S SAMPLE TYPESAMPLE TYPE C = Core D = DentionTopBottom DepthSAMPLE TYPE S SAMPLE TYPEA A Auger T Balely Tube C = Core D = DentionTopBottom DepthSAMPLE TYPE S SAMPLE TYPE (FT.)SAMPLE TYPE SCORE C = Core D (ft. & RQD No.PROGRESS Well	PROJECT: CTO NO.: COORDINA ELEVATION	TES:	Treats 323 EAST: SURFACE	<u></u>	y_Sti	rdy I	BORING NO.: NORTH: TOP OF PVC CASING:					Plume MW355	Plume C MW3558B		
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	RIG: # 82	)								WEATHER					
$\begin{array}{c c c c c c c c c c c c c c c c c c c $				CASIN	G AU	GERS			_	(	(FT.)		(FT.)		
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	SIZE (DIA)	M.)	1-3/8"		6-	1/4"		8-26	-96	0	-34.0	mostly cloudy warm (80's)			
HAMMER WT.140 lbs.InstructionFALL30"InstructionSTICK UPStructureS.3" (bgs). Sampled at 5' intervals from 5.0" (bgs) to 32.0" (bgs)REMARKS: Augaration for the set ground is .4 $\rho\rhom$ WellDiam.S = Split SpoonA = AugerWellInformationT = Shelby TubeW = WashC = CoreRiserR = Air RotaryC = CoreP = PistonD = DenisonN = No SampleScreenN = No SampleScreen2.0"StatulationInto set ground is .4 $\rho\rhom$ Visual Description(ft.)Rec. orID(ft.)Rec. orIDNo.%No.(ft.)Rop No.PIDNo.%Auger to 5.0" (bgs)1Auger to 5.0" (bgs)2Auger to 5.0" (bgs)3Auger to 5.0" (bgs)4Auger to 5.0" (bgs)4Auger to 5.0" (bgs)55.06S - (3Auger to 5.0" (bgs)4Auger to 5.0" (bgs)55.06S - (3Auger to 5.0" (bgs)4Auger to 5.0" (bgs)6S - (3Auger to 5.0" (bgs)4Auger to 5.0" (bgs)6S - (7Z - (8N <td></td> <td></td> <td></td> <td></td> <td>5</td> <td>.0</td> <td></td> <td><u> </u></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>I</td>					5	.0		<u> </u>						I	
FALL30"STICK UPREMARKS: Augared to S.3' (bgs). Sampled at S' Intervals from S.3' (bgs) to 32.0' (bgs)Haw back grouwd is .4 ppmSAMPLE TYPES = Split SpoonT = Shelby TubeW = WashR = Air RotaryD = DenisonN = No SampleWellInformation(ft.)Typeand(ft.)TypeRedorand(ft.)No.%)123A+NN445562.123A+NN44455562.1231412314455.024455.0244455.024455.024455.062.12.144455.062.12344					H	SA									
STICK UPREMARKS: Augarad to S.0'(bgs), Sampled at S' Intervals from S.0'(bgs) to 32.0'(bgs) Haw background is $4 ppm$ SAMPLE TYPE S = Split SpoonN = Auger W = Wash R = Air RotaryTop DepthBottom DepthSAMPLE TYPE D = DenisonWell InformationDiam.Top DepthBottom DepthN = No SampleWell ID ID (ft.)Top Schedule 40 PVCBottom DepthN = No SampleVisual DescriptionWell Installation DetailI ab Rec. and (ft. & RQD No.PID ID ID (ft. & RQD No.Visual DescriptionWell Installation DetailI ab I and (ft. & RQD No.Visual DescriptionVisual Description1IIII2IIIII3IIIII4IIIII2IIIII3IIIII4IIIII5S.0IIII6S-IIIII7Z.0IIII9NIIII9N <tdi< td=""><td></td><td>WT.</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>ļ</td><td></td></tdi<>		WT.											ļ		
REMARKS: Augarad to S.G. (bgs). Sampled at S' intervals from S.G. (bgs) to 320' (bgs)SAMPLE TYPES=Split SpoonA = AugerTop DepthBottomTop DepthBottomReservation of the second			30"											<u> </u>	
How background is .4 ppmSAMPLE TYPE S = Split SpoonNew Well W = Wash R = Air RotaryDiam.TypeTop DepthDepth DepthR = Auger D = DenisonN = No SampleN = No SamplePID ID (ft.)Well ScreenDiam.Type PVCTop Depth Depth (ft.)Depth Depth (ft.)N = No SamplePID Rec or Rec or (ft. & RQDNo.PethSamp.SPT Rec or Rec or No.A Auger to 5.0' (bgS)Well Installation DetailElevation (ft. MSL)1Centre V totsite. Oxidation (orcange) Staining will brown, Soft to mediate Stiff, dampN-445So6789N10111 <t< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td><u> </u></td><td></td><td></td><td></td><td></td><td></td><td></td></t<>								<u> </u>							
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	REMARKS	HNI	r back	groun			<b>`</b>					( 5.0° (695)			
$\begin{array}{c c c c c c c c c c c c c c c c c c c $		Split Sp	oon			-					1920		Depth	Depth T	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	R = 4	R = Air Rotary $C = Core$				Rise	er	2	.0"		e 40	+3.0	-21.0 -		
(ft.) Type Rec. or ID No. (ppm) Visual Description Well Installation Detail Elevation (ft. & RQD No. %) No. (ppm) Visual Description $Cancel vrt$ 1						Scre	en	1 2 0" 1				-21.0	-31.0		
$\begin{array}{c} 2 \\ 3 \\ 3 \\ 4 \\ 4 \\ 4 \\ 4 \\ 4 \\ 4 \\ 5 \\ 5 \\ 5 \\ 5 \\ 6 \\ 7 \\ 7 \\ 7 \\ 7 \\ 7 \\ 7 \\ 7 \\ 7 \\ 7 \\ 7$	-	Type and	Rec. (ft. &	or	ID	1		Visual	Des	cripti	on	Installat	ion	1.	
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$		A-N	-				Auge	r to	5.	٥' (	-  		~ grot 		
				2			(orav heau Blue brou	ige)s ier " ish g wn, s	ta; 10 50f	viv eale 19 EE	ig will deposits rayish			Ī	
	- 9		-	-		.4/4	Stif	t' 90	ι.vn	·P	-  			T	
	100.0					·4/.4	CLAY	is Sil	t N	Aatch	to Sheet 2	2			

DRILLER: R. Bush

BORING NO.: MW3558B SHEET I OF 📻

# Baker

### TEST BORING AND WELL CONSTRUCTION RECORD

Baker Environmental, me

PROJECT: CTO NO.:

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Treatability Study In-Situ Air Sparging Plume C 323 BORINGNO .: MW3558B

		MPLE '	ГҮРЕ		·	DEFINIT				
	plit Spoc helby Tu			A = Au W = W	÷	SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5') RQD = Rock Quality Designation (%)				
R = A	Air Rotar			C = Co	re	PID = Photoionization Detector	-7			
D = I	Denison N	I = No Sa	mnle	$\mathbf{P} = \mathbf{Pis}$	ton	ppm = parts per million				
Depth	Samp.	Samp.	SPT	Lab	PID	· · · · · · · · · · · · · · · · · · ·	Well			
(ft.)	Туре	Rec.	or	ID No.	(ppm)	Visual Description	Installation	Elevation		
	and No.	(ft. & %)	RQD	INU.			Detail	(ft. MSL)		
		1.8	3		4	Continued from Sheet 1	77 -			
11	5-2	2.0	m 4 4 m		.4	Sandy CLAY willittle sit		L		
12 12.0		90%	3			Oxidation (orange) streaks Grayish brown to gray,	centi qra	ent		
13 _						soft to medium stift				
	N				.4	damp to moist -				
14					.4		2" 0			
15 _15.0					<i></i>					
16	_	1.5	WOH		.4,	CLAY WISILT. Dark -				
	5-3		18"		.4	olive gray, soft (quite plastic), damp-				
1717.0		75%								
18						_		onite		
	N				.4	_	Pel Pel	lats		
19	10				.4		888 <b>#8</b> 8 —			
20 _ 20.0						-				
21		1.0 N.O	4		.4,	-				
	5-4		400		.4	SAWD, fine to coarse -				
2222.0		80%				grained witrace -	- Sav pag			
23	•					silt. Dark gray to -				
_	N				.4	brown, loose, wet	inoci internet			
24					.4	_	Sere	en		
2525.0						-				
26	<u> </u>	1.4	とくの		A	SAND, fine to medium grained, tr. silt, Oxidation				
	5-5				.4	(brownish orange)				
27 <b>27.</b> 0		70%	4		<b> </b>	staining is heavy Brown, 10030, wet				
28						010000,10030100011				
	N				.4					
29		r.			.4	_				
3030.0										
DRILLING C	xo.: <u>F</u>	gurat	<u>t- 12</u>	oitt		BAKER REP.: <u>J. E. 2</u>	Zimmerman			
DRILLER:	R	Bus	h			BORING NO .: MW35	58 <u>8</u> SI	IEET 2 OF :		



Treatability Study In-Situ Air Sparging Plume C PROJECT: 323 BÒRINĞ NO.: MW3558B CTO NO .: DEFINITIONS SAMPLE TYPE SPT = Standard Penetration Test (ASTM D-1586)(Blows/0.5') S = Split SpoonA = Auger W = Wash**ROD** = Rock Quality Designation (%) T = Shelby Tube **PID** = Photoionization Detector  $\mathbf{C} = \operatorname{Core}$  $\mathbf{R} = \mathbf{Air} \mathbf{Rotary}$ ppm = parts per million $\mathbf{D} = \text{Denison}$  $\mathbf{P} = \text{Piston}$ N = No Sample Lab PID Depth Samp. Samp. SPT Well Elevation D (ppm) Rec. οг (ft.) Type Installation Visual Description (ft. MSL) No. (ft. & RQD and Detail %) No. well Scraan 1.9 Continued from Sheet 10 Continued from Sneel SAND, Fine to medium grained, tr. Silt, littlet Some cemented sand sand 13 4 31 2.0 1:4410-40 padk 5-6 .4 15 sione nodules, to to some commented shet mat. (she if frogs. 95% 17 320 32 ٦ 2.0 .4 -33 2.0 5-7 10 SAND, Fine grained, tr wart .4 Silt, tr clay, tr. Shell Breenish gray/white 13 plug 100% 34 34.0 End of Boring 35 TD= 34.0' (bgs) 6 7 8 9 0 1 2 •3 4 5 :6 7 8 9 0 DRILLING CO .: Parratt- Wolff BAKER REP .: J.E. Zimmerman BORING NO .: MW3558B SHEET 3OF R. Bush DRILLER: